AIR ENGINEERING

THE UNIVERSITY OF MICHIGAN
OCT 19 1960
ENGINEERING

OCTOBER, 1960

AIR POLLUTION CONTROL • AIR MOVING • AIR CONDITIONING

- *"Fingerprinting" Airborne Dusts For Super-Clean Areas*
- *Practical Ways To Ventilate Batch And Continuous Filters*
- *Steel Melting Furnace Emission Control . . . Cost Data*

To Engineer Ultra-Violet Light Air Sanitation Systems, P. 30

ADVERTISEMENT

The unseen enemy

How Summers Gyroscope guards against the invisible anti-missile

Vacuum equipment at each of the 240 individual assembly benches helps insure product reliability.

There is an invisible enemy operating in many plants producing the missile components, flight instruments, gyroscopes and other hyper-sensitive devices on which much of America's power for peace depends. The strength of this unseen foe is potentially as great as that of any anti-missile missile.

Destroyer Of Standards

This reliability destroying, efficiency reducing enemy is dust, lint and other foreign matter. The slightest air borne contaminant coming to rest unseen on sensitive mechanisms during assembly can cause serious, even fatal deviations in performance. Production was often slowed until tests showed the system to be free of dust.

Dust Moved But Not Removed

To combat the dust dilemma at the Summers Gyroscope Co. plant in Santa Monica, California, personnel donned lint free jackets and hats – walked to their work benches in shoe bags. Temperature and humidity were controlled in an attempt to achieve an environment completely free of every possible contaminant ranging from stray hairs to perspiration. However, these precautions proved only partially successful when it was found that a manual dust gathering system in the final assembly "clean room" actually recirculated dust instead of removing it.

Double Duty Production Tool

For a solution to the dust menace, Summers called upon U.S. Hoffman Machinery Corp., pioneers in the use of air as a production tool. Hoffman engineers installed a permanent stationary vacuum cleaning system which provided for necessary cleaning operations at all of the 240 individual work benches in the 12,000 square foot final assembly area. Standard attachments made this same system available for cleaning overhead and under foot, all over the plant.

Before And After

Prior to the installation of the Hoffman stationary system, relative cleanliness tests were conducted. A microscopic analysis of slides revealed lint, dust and other foreign matter in excess of quantities allowable to maintain Summers' high precision standards. A short time after the Hoffman equipment was placed in operation, the same tests showed a truly dust free "clean room".

How It Operates

Heart of the stationary cleaning system at the Summers plant is a 60 hp Hoffman centrifugal exhauster producing the vacuum. A centrally located dust separator outside the assembly rooms collects the material with large filtering area insuring thorough cleaning of the air. Hoses for cleaning are inserted into strategically located inlet valves in the piping system conveniently located throughout the areas to be vacuumed.

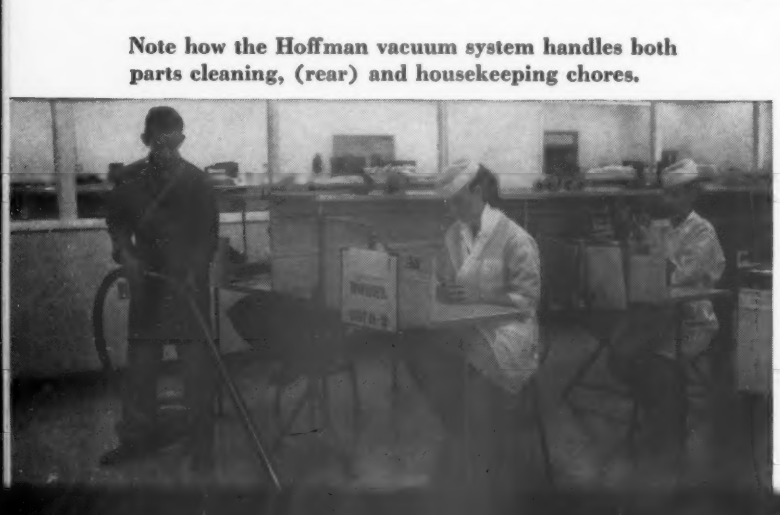
Benefits And Advantages

Insuring spotlessly clean work in final assembly and calibration, the Hoffman stationary vacuum system already has paid for itself. It has helped Summers Gyroscope reduce rejects, maintain high reliabilty, increase production and improve employee morale. The Hoffman system enables Summers to meet and exceed specifications in supplying inertial guidance systems, flight instruments and gyroscopes to the U. S. Air Force, U. S. Navy, the Martin Co., McDonnell Aircraft, Douglas Aircraft and the Convair Div. of General Dynamics, among others.

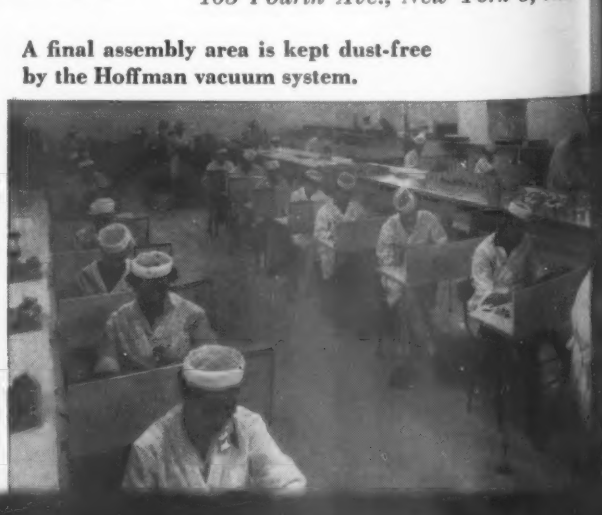
If you have a special cleaning problem in your plant, ask for a free engineering survey to determine the most economical Hoffman system to prevent product contamination, salvage valuable materials, insure better housekeeping and encourage operating efficiency. Write for free booklet – How Stationary Vacuum Cleaning Systems Cut Costs, Increase Plant Efficiency.

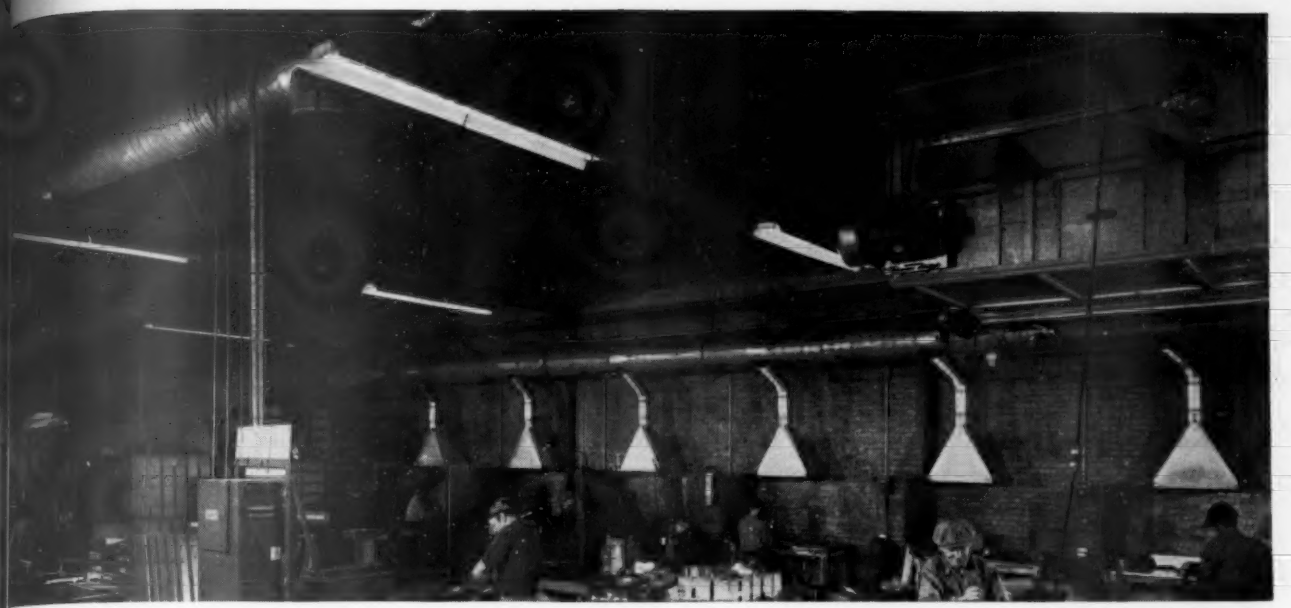
U. S. Hoffman Machinery Corp.
Dept. MD-6 Air Appliance Division
103 Fourth Ave., New York 3, N.Y.

Note how the Hoffman vacuum system handles both parts cleaning, (rear) and housekeeping chores.



A final assembly area is kept dust-free by the Hoffman vacuum system.





At top left in this plant in which sheet metal specialties are produced, there's a run of 24-inch Carrier Spira-Pipe as integral part of the Carrier Air Conditioning System. Fumes from six welding machines along the wall are vented, using a Carrier Fan Section and 22-inch Spira-Pipe — with 12-inch branches at each hood.

HOW CARRIER SPIRA-PIPE AND FITTINGS SIMPLIFY EXHAUST SYSTEM LAYOUTS

On all types of exhaust systems for fumes, dust and heat, you can eliminate costly layout time, shop and job-site fabrication by using Carrier Spira-Pipe* and fittings. You have a wide selection of lengths up to 20 feet and 16 diameters from 3 through 24 inches—any fractional diameter also available on special order. Spira-Pipe is easily cut on the job. Weighs but a fraction of other types for the same duty. And, fabricated from zinc-coated steel, copper and other metals, it has a 4-ply lockseam construction that provides exceptional strength and rigidity.

To further simplify system layouts and reduce job-site assembly and fabrication costs, standard Carrier fittings include all types and matching sizes. For fast and convenient service, Carrier maintains seven field shops in New York, Philadelphia, Atlanta, Chicago, Dallas, Los Angeles and Toronto.

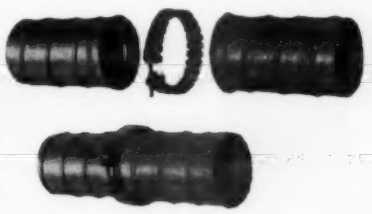
Want complete information on time-saving Spira-Pipe and fittings? Write Carrier Air Conditioning Company, Syracuse 1, New York. In Canada: Carrier Air Conditioning Ltd., Toronto.

*Trademark

Typical of a complete line of fittings, including die-formed elbows, available for each diameter of Spira-Pipe.

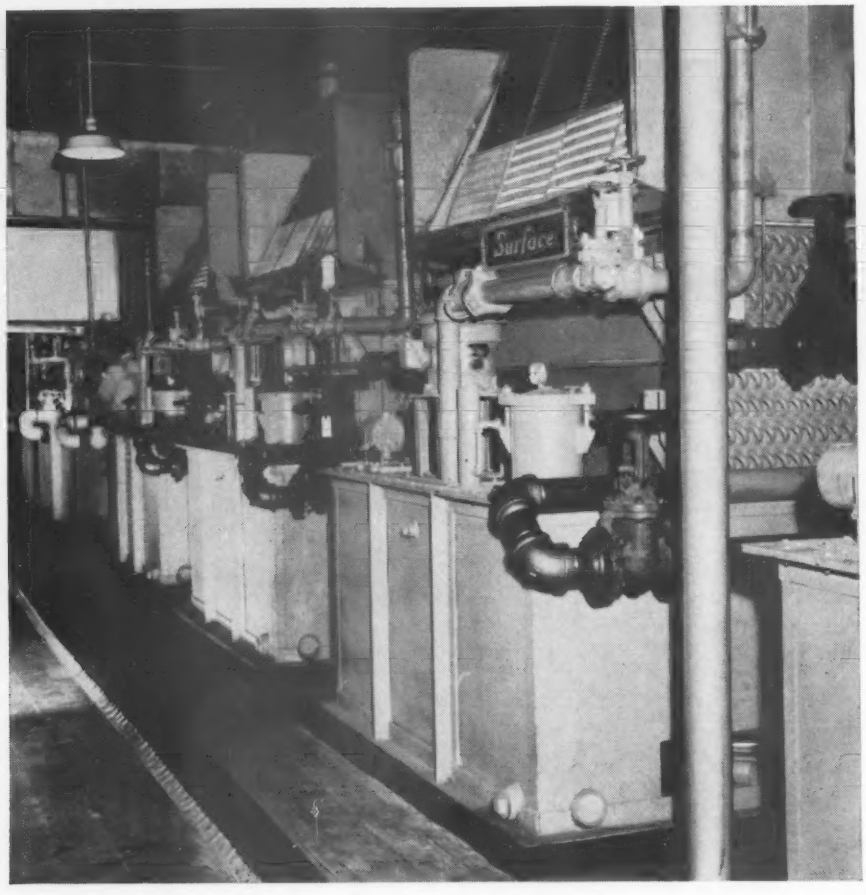
90° die-formed elbow 45° die-formed elbow 90° regular cross

Carrier "Quick-Connector" Fittings, using Marman "Venti-duct," clamp pipe together in minimum time, provide a positive air-tight seal, permit quick disassembly.



Carrier Air Conditioning Company

A DIVISION OF CARRIER CORPORATION



120 GRAINS CUT TO 45 IN 200,000 cfm OF AIR WITH 85° TOWER WATER

Without Kathabar, this job would have taken 1800 tons of refrigeration, at about 35F and reheating air from about 45F to 98F! With Kathabar the job took 63 hp instead of 2000. Ask the men who have seen Kathabar Type C units serve for years with practically no maintenance. Write for specific information.

Surface

SURFACE COMBUSTION

Division of Midland-Ross Corporation MR

2394 Dorr St., Toledo 1, Ohio

Send facts on Kathabar systems for the following application:

name and title.....

company.....

street.....

city.....*zone*.....*state*.....

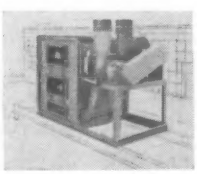
Watch For These Articles Next Month!

WHITE ROOMS FOR PROJECT MERCURY!

Controls for manned Space capsules must function perfectly at all times. "White Rooms" at McDonnell Aviation are used for final assembly of these controls. Article tells all about "White Rooms", air filtration, air conditioning, room construction.

AIR CONDITIONING A SEMI-CONDUCTOR FACTORY

Sealed-off production areas termed "air-critical" occupy all but 14,000 sq. ft. of Rheem's new 100,000 sq. ft. electronic plant in Calif. Even utility tunnels are under negative pressure. Article gives valuable data on this demanding air conditioning job.



NEW GAS-LIQUID SCRUBBER WITH HIGH EFFICIENCY

For scrubbing jobs such as hydrochloric acid, vapors from hot vegetable oils, volatile amines, SO_2 from hot steam, oxides of nitrogen, a new wet scrubber claims up to 100 percent.

Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, new products, new items, etc.

If you wish to contact manufacturers directly, street addresses are given. But please mention you saw it in AIR ENGINEERING.

AIR ENGINEERING

VOL. 2, NO. 10

OCTOBER, 1960

DEDICATED TO THE SCIENCE OF AIR POLLUTION CONTROL
AIR MOVING • AIR CONDITIONING

FEATURES

How To Apply, Select, Install, Maintain Ultra-Violet Light Systems 30
For air sanitation in schools, hospitals, bakeries, pharmaceutical plants

For The Chemical Industry . . . Filter Ventilation Methods 37
Hood design, data on mechanical exhaust ventilation, for batch and continuous filters

Control Of Electric Furnace Emissions, Part II 42
Source, cost data, dust loading calculations, hood design

Beryllium Processing . . . Dust Control Techniques, Part IV 48
Monitoring, duct design, personnel safety

"Fingerprinting" Airborne Dusts For Super-Clean Areas 51
Helps you track dust back to its source in the plant

Growth Of A Baghouse 56
Rare, step-by-step photos of baghouse being installed in cement plant

DEPARTMENTS

Next Month 2
Letters 4
Editorial 7
Meetings 8
Newsletter 10
News of the Industry 12
Air Pollution Complaint$ 18
New Literature 23
New Products 24
Communications Center 57
Questions & Answers 65
Classified Ads 66
Professional Services 66
Advertisers Index .....3rd Cover

COVER

Cover shows bank of ultraviolet lights in an air conditioning system. UV lights sanitize air. For more details, please see story on UV use in schools, hospitals, factories, beginning on page 30. Cover color photo was furnished by Lamp Div., Westinghouse Electric Corporation.

AIR ENGINEERING is published monthly by Business News Publishing Company, at 450 West Fort Street, Detroit 26, Michigan. Subscription prices: United States, Canada: $3.00—1 year; $4.50—2 years; $6.00—3 years. Foreign: $5.00—1 year; $8.50—2 years; $12.00—3 years. Single copies 50 cents. Second-class postage paid at Detroit, Michigan. First issue April, 1959. • CHANGE OF ADDRESS. Notify AIR ENGINEERING and your local post-office of both your old and new addresses including postal zone numbers by 12th of preceding month.

• CONTENTS COPYRIGHT 1960 by Business News Publishing Company. Reproduction of material may not be made without written permission of the publisher.

Call on Rhodia "Odor Engineering" to solve your malodor problems in plant or product

Rhodia Inc. is the world leader in industrial odor control and reodorization technology and a primary producer of industrial aromatic chemicals. It offers fully qualified consultation service anywhere in the United States without cost or obligation.

RHODIA INC., 32-2
60 East 56 St., New York 22, New York
Gentlemen:
Please send me Rhodia literature.
My problem is: (please give specifics)

_____

_____

_____

NAME_____

ADDRESS_____

CITY_____STATE_____

RHODIA INC.
60 East 56 St., New York 22, New York
(Phone: PLaza 3-4850)

Letters

"Educated" Wind?

Editor:

Every observer of motion pictures has seen remarkable occurrences in such pictures, to many of which engineer spectators have been inclined to add a pinch or two of salt.

For example I have before me a photograph which appeared in a popular picture magazine several years ago—a picture of a huge tank of water being blown over by a "simoon". The caption beneath the picture states, "The precious water tank, so essential in building the ditch through the desert, is tipped by the simoon. The struggle to save it fails. A great gust topples it—".

The photograph shows a ladder running up the side of the tank with 15 rungs in it, from which this writer estimates that the height of the tank is about 20 ft. As a matter of fact it probably is a tiny model, such as commonly used by motion picture producers, made to *look* big by clever manipulation. Anyway, the tank *looks* as though it is at least 20 ft. high by 16 ft. in diameter.

Now, any reader can easily figure the weight of water that would be held by such a tank. On the basis of 62.5 pounds per cubic foot the weight of that amount of water would be 250,000 pounds.

The important question now is: what wind pressure will be required to blow that tank over—and it is actually shown in the process of being blown over in the picture, with water spilling out. Much, of course, depends upon the foundation beneath the tank. If the foundation is weak on one side it might be possible for the tank to topple over without any wind at all. Such a thing did happen in Fargo, N. Dak. on June 12th, 1955, when twenty huge cylindrical storage tanks, 122 ft. high, built of reinforced concrete, toppled over. The structure was only one year old. It was loaded with 600,000 bushels of grain.

On the other hand there is the Tower of Pisa which has been leaning for many years. Between 1829 and 1910 it listed 12 in. During recent years the world has become alarmed over the increasing rate of inclination of the tower. The greater the lean the greater the pressure on the "toe" or the lowest edge of the tower's foundation. Cement has been placed under the toe and even after that the inclination has increased a bit, but it is hoped that there will be no more and that Pisa will continue to lean without falling for many centuries to come.

So, returning to our *Windstorm*, with a first class A-No. 1 foundation under the water tank, and computing the stability of a tank of water, the writer finds that a wind pressure of 625 lbs/sq. ft. on the projected area of the tank would be necessary to blow such a tank over. If you wish to check these figures the writer is certain that you will arrive at approximately the same result.

However, this tank as shown is cylindrical—like a round chimney—and if you will look the matter up in an engineering text book you will find that the actual pressure per sq. ft. on a flat surface is divided by two when computing the pressure against the projected area of a round object. Hence we would do the same in this instance. Therefore to arrive at the wind pressure that would be exerted against a flat surface we must *multiply* by two, and we get 1250 lbs./sq. ft. exerted by this "movie wind", all of which, admittedly, is *some* wind.

Check Velocity

Now let us determine the velocity of that wind. The formula given in our handbooks tells us to square the velocity of the wind in miles per hour and multiply that by 0.005. The result is the pressure in pounds per sq. ft. Using that formula you will find that the wind velocity necessary to blow the tank over would be 500 miles per hour, which is the highest wind velocity this writer has every heard of. It is quite possible, though, that such velocities are now created in the testing tunnels used in airplane experiments. The writer is informed, for instance, that when a man drops out of an airplane or balloon in making a parachute descent he never falls faster than 200 miles per hour, even with the parachute closed, on account of the high air resistance when 200 miles per hour is reached.

These figures are exceptionally interesting to the writer because,

(Please turn to page 60)

WE TAME EFFLUENTS

• • • LET US TACKLE THE ONE *YOU'RE* BREWING UP!

Here are some of the effluents tamed by 'Buffalo' Engineers and 'Buffalo' equipment:

● Coke Breeze ● Soluble gases, vapors, mists
● 1000° corrosive gases ● Metallic fumes
● SO_2 and SO_3 process gases (recovered) ● Lampblack
● Heavy dusts, rock dusts ● Tar Vapor ● Acid Mists

This is where 'Buffalo' and its half-century of experience in air cleaning come in. No matter how complicated the problem may seem, chances are that we've solved a similar one. Sometimes it's taken a lot of research, designing of new equipment, constructing pilot plants and modification—but the problem has always been solved to complete satisfaction. This wealth of information has been added to our files. And 'Buffalo' Air Cleaning Equipment has been engineered to the latest requirements of this information.

Again we say: "Toss your effluent problem to us" for the best and most economical solution in the light of 50 years' specialization. You'll benefit in "neighbor relations" and, very possibly, in valuable product recovery. Write for Bulletins AP-225, AP-425, AP-525, and 2424-F or contact your nearby 'Buffalo' representative.

AIR HANDLING DIVISION
BUFFALO FORGE COMPANY
Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

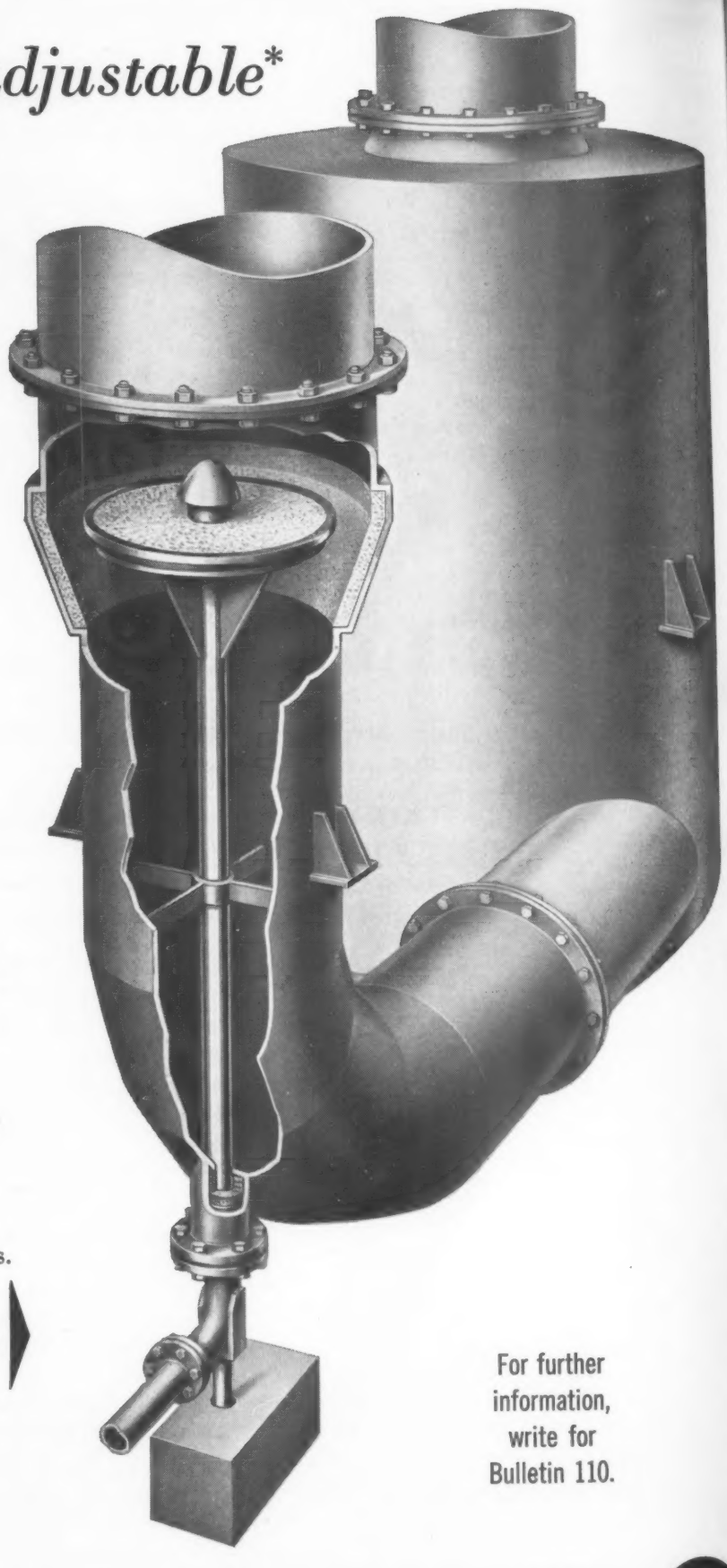
Buffalo Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

*Completely adjustable**

Flooded Disc Scrubber

Removes Sub-Micron Fumes



The Research-Cottrell high efficiency scrubber uses the unique flooded disc principle for removing sub-micron fumes in steel-making furnaces and chemical processing.

As shown in the illustration, the outstanding feature of this scrubber is the simple, adjustable "flooded disc." The flooded disc adjusts for maximum cleaning efficiency over a wide range of operating conditions.

* *Automatic positioner immediately adjusts the disc to meet your varying gas and dust control problems.*

Research-Cottrell, with over 48 years of industrial gas cleaning experience, will be glad to consult with you on any specific problem.

For further information, write for Bulletin 110.

Research-Cottrell

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.
Representatives in principal cities of U.S. and Canada

RESEARCH COTTRELL INC TRADE MARK RC207

AIR ENGINEERING

Publisher: E. L. Henderson
Assistant Publishing Manager: P. A. Schildhammer
Editor: Eugene A. Sloane
Assistant Editor: George M. Hanning
Assistant Editor: Hugh T. Mahar
Research Manager: John A. MacLean
Advertising Manager: Alfred Chadburn
Advertising Production Manager: A. M. Barrow
Circulation Manager: R. M. Ashley
EDITORIAL ADVISORY BOARD: George F. Taubeneck • Phil B. Redeker • C. Dale Mericle
REPRESENTATIVES: NEW YORK 17—521 Fifth Ave., MUrray Hill 2-1928-9, R. M. Price, F. L. Taylor.
CHICAGO 3—134 S. LaSalle St., FRanklin 2-8643-4, M. R. Smith.
DETROIT 26—450 W. Fort St., WOodward 2-0924, Alfred Chadburn.
LOS ANGELES 43—4710 Crenshaw Blvd., AXminster 2-9501, J. A. Hannon.

EDITORIAL:

On Communication Between Engineers and Architects . . .

ONE OF THE MOST common gaps in the communication of ideas between architects and consulting engineers is a lack of knowledge on the part of the architect about mechanical systems in buildings.

In our opinion, schools of architecture are remiss in their training of aspiring architects if their graduates do not leave with a firm grasp of how best to fit mechanical equipment into the building design.

Deciding where and how to fit, blend and hide mechanical equipment, (not always a thing of beauty and a joy forever) within the building is *not* one of the functions of the engineer. And even if it were, the consulting engineer is frequently added to the team (owner, architect, general contractor) far too late to be of much real help in doing anything radical to the already "frozen" building design.

If the architect knew just a little about the basic types of mechanical systems, he would be in a far better position to serve his client by designing a building that is not just a monument, but a building with real comfort and utility as well as beauty.

Fred Dubin, a consulting engineer from Hartford, Conn., said in a lecture to architectural students at Yale University, "with greater familiarity about types of mechanical systems, the architect can make far more intelligent demands on his engineers, better evaluate claims and counter-claims of manufacturers' representatives, salesmen and the myriad of advertising which awaits him on entering practice. The client deserves the services of an architect who can produce a building that is the most beautiful, most utilitarian and most economical to build, maintain and operate, within his budget. Thorough integration of the mechanical system with the building structure enables the architect to exercise greater freedom in utilization of space and materials, and gives him wider scope for aesthetic expression."

"An architect should have some knowledge of the economics of mechanical systems, of what initial installation costs are which produce specified degrees of comfort. He should understand the relation between operating costs and maintenance costs with initial installation costs. For every 100 sq. ft. of

(Please turn to following page)

Editorial (Cont.)

On Communication Between Engineers and Architects . . .

(Continued from preceding page)

glass improperly shaded, or oriented, for instance, an additional ton of refrigeration is required, at a cost of $600-1000 per ton."

Thus, the architect, to be able to communicate effectively with the engineer so as to produce a building which serves the best interests of the owner, should know how building design and structure affect mechanical equipment choice and system design, which contribute to the comfort of building occupants.

Says Mr. Dubin: "The concepts of comfort and utility which are realized in part by air movement, temperature control, humidity, air cleaning and sound control, are necessary in order to produce a building which is more than juxtaposition of stone, glass, wood and metal . . . enclosing space."

We agree with Mr. Dubin that the architect should take the lead in suggesting ways to hide engineering systems in the building, and not wait for the engineer to produce them. For example, the architect can dramatize the boiler room by painting and color coding equipment and piping, and putting it behind a glass wall for all to observe, thus making the power plant itself an expression of beauty as well as utility.

"Exposed piping," said Mr. Dubin, "banks of conduits and ducts, can be fabricated in gentle turns, broad sweeps or other forms which enhance the character of the building. Where an air handling or conditioning unit cannot be hid completely, it can be encased in a glass cabinet so that its inner workings are exposed. . . ."

The architect should know enough about mechanical systems to demand that these human needs be met . . . and be able to communicate effectively with the engineer early enough in the building design stage, to avoid that compromise between architectural and engineering design which hurts both.

Communication is a two-way street. It's time, in our opinion, for curricula planners in schools of architecture to add or improve survey courses on mechanical systems and equipment. These studies should give the new architect the technical background for meaningful communication with engineers . . . which will result in buildings attractive to eye and comfortable to body. ▲▲

Eugene A. Sloane

Editor

Meetings, Courses, Expositions

Fourth Western Industrial Health Conference, *San Francisco, Calif., Oct. 7-9.*

American Gas Association, 42nd Annual Convention, *Convention Hall, Atlantic City, N. J., Oct. 9-12.*

National Metal Exposition, *Philadelphia Trade and Convention Center, Philadelphia, Oct. 17-21.*

Air Pollution Control Association, West Coast Section, Second Technical Meeting, *Santa Barbara Biltmore Hotel, Santa Barbara, Calif., Oct. 20-21.*

National Electrical Contractors Association Show, *Convention Center, Las Vegas, Nev. Oct. 23-27.*

ASME-AIME Fuels Conference, *Charleston, W. Va., Oct. 24-25.*

Industrial Hygiene Foundation of America, Inc. 25th annual meeting, *Mellon Institute, Pittsburgh, Oct. 26-27.*

Air Conditioning and Refrigeration Wholesalers, Annual Meeting, *aboard S.S. Hanseatic, from Ft. Everglade, Fla., Oct. 28-Nov. 2.*

Institute of Boiler and Radiator Manufacturers semi-annual meeting, *Seaview Country Club, Absecon, N. J., Week of Oct. 31.*

The Institute of Boiler and Radiator Manufacturers, Semi-Annual Meeting, *Seaview Country Club, Absecon, N. J., week of Oct. 31.*

American Institute of Plant Engineers; Subject: White Rooms, *Phoenix Arizona, Nov. 1. Contact: Chris Gort, Sperry Rand, Phoenix Division, Nineteenth Ave., Phone WIndsor 3-2311 for details.*

National Hotel Exposition, *New York Coliseum, New York City, Nov. 7-11.*

At Robert A. Taft Sanitary Engineering Center, Cincinnati, consecutive courses. *Control of Particulate Emissions Nov. 7-11; Control of Gaseous Emissions, Nov. 14-16.*

Building Research Institute Fall Conference, *Shoreham hotel, Washington, D. C., Nov. 15-17.*

Mid-Atlantic States Section Meeting, *Consolidated Edison Co., New York, Nov. 17.*

Air-Conditioning and Refrigeration Institute annual meeting, *Hollywood Beach hotel, Hollywood Beach, Fla., Nov. 18-22.*

Refrigeration and Air Conditioning Contractors Association convention, *Fontainebleau hotel, Miami Beach, Fla., Nov. 20-23.*

Heat Transfer Division, ASME, 1960 Winter Annual Meeting, *Statler Hilton Hotel, New York City, Nov. 27-Dec. 2.*

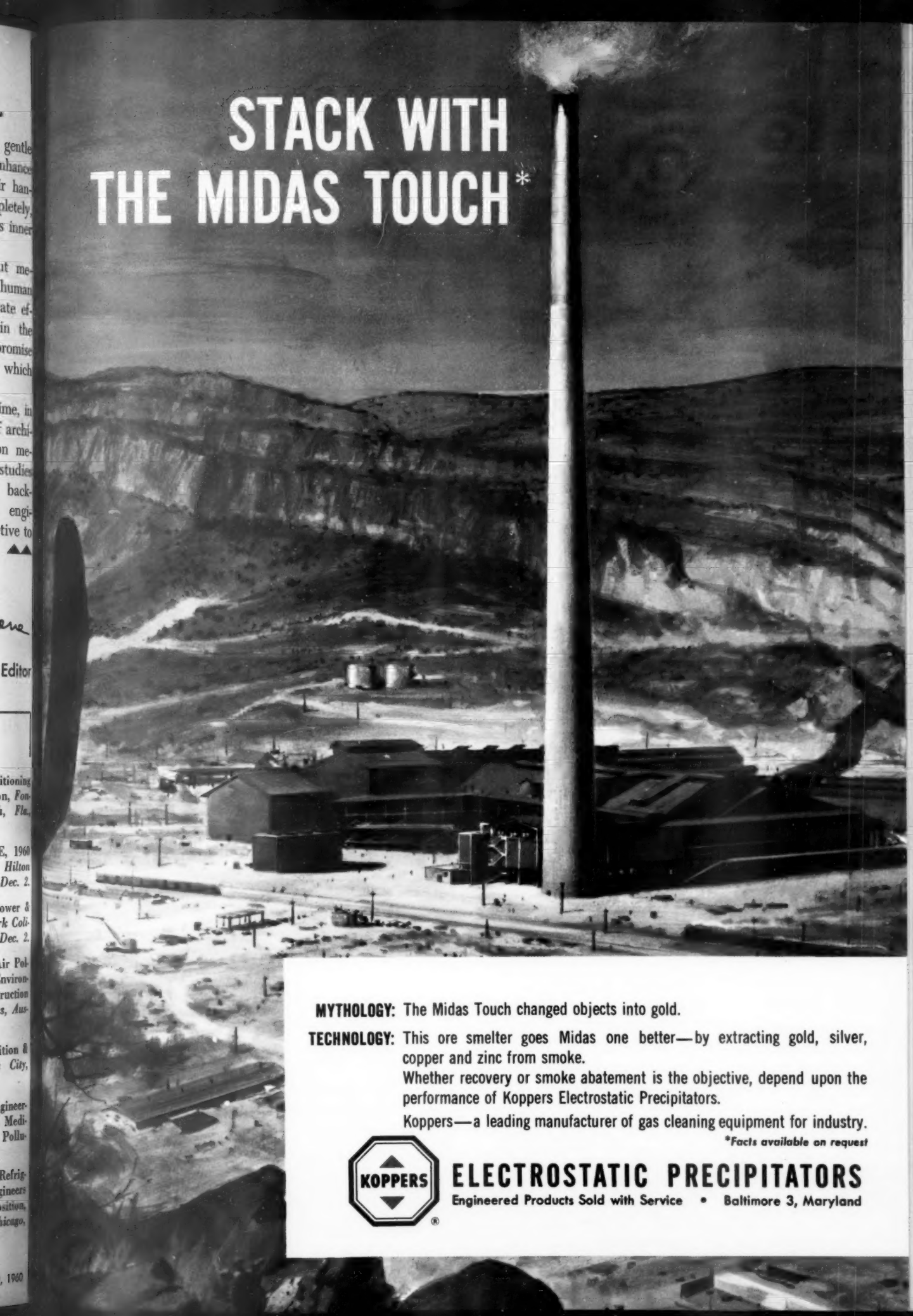
24th National Exposition of Power & Mechanical Engineering, *New York Coliseum, New York City, Nov. 28-Dec. 2.*

Sixth Industrial Hygiene and Air Pollution Conference on New Environmental Problems in The Construction Industry, *The University of Texas, Austin, Texas, Dec. 3.*

First Industrial Building Exposition & Congress, *Coliseum, New York City, Dec. 12-15.*

At Robert A. Taft Sanitary Engineering Center, Cincinnati. Course in Medical and Biological Aspects of Air Pollution, *Dec. 12-16.*

American Society of Heating, Refrigerating, and Air-Conditioning Engineers semi-annual meeting and exposition, *International Amphitheatre, Chicago, Feb. 13-16, 1961.*



MYTHOLOGY: The Midas Touch changed objects into gold.

TECHNOLOGY: This ore smelter goes Midas one better—by extracting gold, silver, copper and zinc from smoke.

Whether recovery or smoke abatement is the objective, depend upon the performance of Koppers Electrostatic Precipitators.

Koppers—a leading manufacturer of gas cleaning equipment for industry.

Facts available on request

KOPPERS®

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with Service • Baltimore 3, Maryland

Modine To Expand Heating, Cooling Lines

Modine Mfg. Co., Racine, Wis., has announced expansion of its product line in three areas. In the heat radiation field, the company will produce finned tube radiation and baseboard heating units.

New chilled water room units will expand the air conditioning line, and new steam, hot water and electric self-contained units will be introduced. An industrial gas heating unit will be included in the heating line.

The expansion is expected to more than double present product lines and to increase sales volume considerably.

G.E. "Snow White" Room Said To Be Ultra Clean

General Electric's "see-in-the-dark" TV camera orthicon tube is assembled in a super-clean area in which air is controlled to a cleanliness of 3000 particles per cubic centimeter of room air.

This is compared with 35,000 dust particles per cc of air conditioned office air and 170,000 particles per cc of heavy industry city air.

"White room" air is monitored by a "condensation nuclei detector" developed by G.E. which can measure particles from .001 microns to 0.1 micron on a light scattering photometer basis for larger particles and on a condensation nuclei basis for smaller particles.

California Smog A Moving Experience

According to a report from the California State Department of Health, about two out of every five adult Californians are bothered by air pollution. Eye and nasal irritation were most frequently reported effects and persons with chronic respiratory conditions were more likely to report most sensitivity to pollution effects.

Report stated that some Californians had given serious thought to moving or changing jobs because of air pollution, and that some had already moved one or more times, chiefly from areas in Los Angeles County. Report also stated that most serious and extensive complaints about air pollution came from Los Angeles County.

Gamma Radiation To Sterilize Hospital Furniture Contemplated

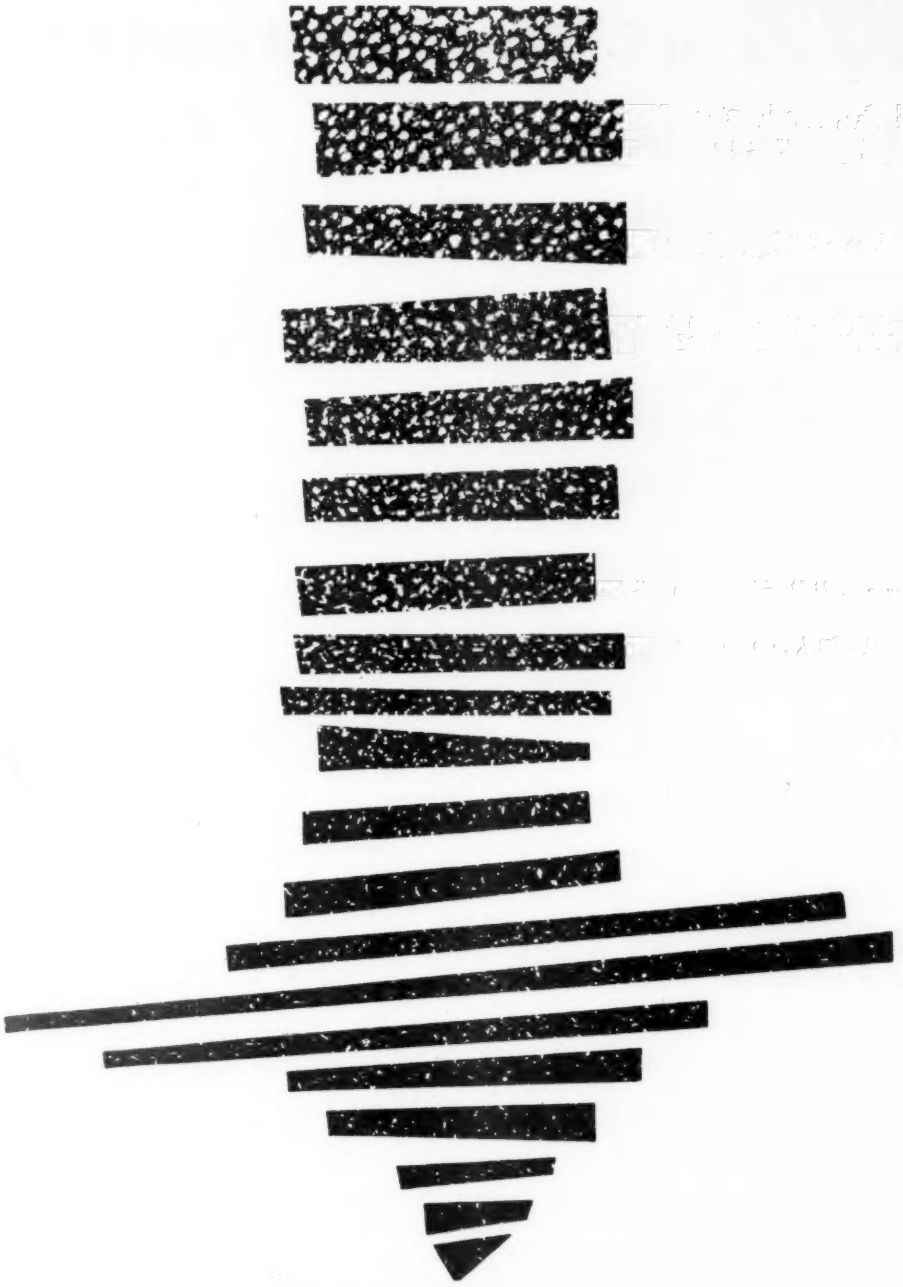
Gamma radiation equipment big enough to take even hospital furniture is being investigated as one method of alleviating the scourge of staphylococcus infections in hospitals.

Staph bugs have been found in talc even after steam autoclaving. So gamma radiation is looked upon as a fool-proof sterilizer, according to H. F. Kraybill and D. C. Brunton, Ph. Ds., in a paper given at the 1960 Nuclear Congress recently held in N.Y.

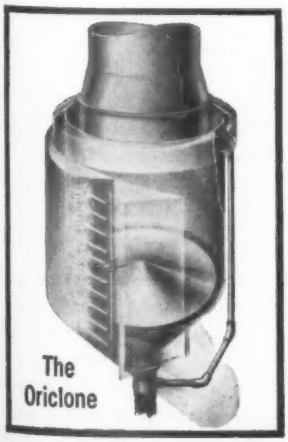
Commercial radiation sterilization of surgical supplies, pharmaceuticals, dressings, etc., has been shown to be competitive with steam sterilization.

Rock'n'Roll Stunts Plants . . . Strauss Waltzes Them Along

Researchers in the U.S. report, in testing effect of noise on plant growth, that Rock'n'Roll music has a decided effect in retarding growth. Tests in British laboratories show that Strauss waltzes, on the other hand, promote plant growth.



exploring the Sub-Micronosphere



The Sub-Micronosphere is the mystifying and challenging province of the small dust and fume particle, the "Submicron," which never exceeds 1/25,000" in size. Submicrons are elusive, wily and extremely difficult to capture... unless you use the right technique. Conquerors of the Sub-Micronosphere have found the Ducon Oriclone Scrubber to be a most effective weapon. It has captured Submicrons by the millions. The Oriclone is a new type of high energy scrubber... smaller... more economical... yet more effective than other units. It is the ideal collector for fine dusts and fumes.

Ask for Bulletin W-8560 and learn more about the Oriclone.

the name in DUst CONtrol

THE **Ducon** COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

Canadian Branch:

THE DUCON COMPANY, of CANADA, Ltd., 1131 Pettit St., BURLINGTON, ONTARIO, CANADA

NEWS of the Industry

British Heat Utilization Proves Economical

According to "Engineering in Britain," industrial waste heat utilization continues to be a "fully economic undertaking." Example cited was a recent installation of plant to produce 3,000 pounds of steam from 1,000 pounds of waste every hour.

In a single year, the $3 million installation saved $1 million, eight hours a day for six days a week. When increased production led to double-shift working, the saving from waste heat utilization was doubled automatically. →

An oil fired, reverberatory downdraught incinerator installed at a British research station for the destruction of infected manure at the rate of 27 cu. ft. in four hours. Photo courtesy of "Engineering In Britain."

Smithsonian Gains Refrigeration "First"

The world's first large cooling machine for air conditioning will have a new home at the Smithsonian Institute in Washington, D. C. The unit is to form the center of a refrigeration exhibition scheduled in 1961.

Developed by the late Dr. Willis Carrier in 1922, it was used for almost 38 years at the Onondaga Pottery china factory in Syracuse.

Moscow Winning AP War

A Soviet sanitation expert in Moscow says the city's air is only one-half as polluted as it was in 1950. The expert reports that over 1,300 dust-trapping devices have been installed in factories and at least six plants.

Fuel Supplement Reduces Exhaust

A gasoline supplement, developed as a direct result of electron microscope studies, manufactured by Fuels Research Corp., Denver, Colo., is said to increase mileage and power by decreasing the amount of unburned fuel escaping the exhaust, thereby reducing air pollution.

The supplement is claimed to reduce gummy particles in liquid fuel, which, although fine, do not burn up instantly when an engine cylinder fires.

25th Annual Engineering Meeting

The 25th annual meeting of the Industrial Hygiene Foundation is to be held at Mellon Institute, Pittsburgh, on Thursday, Oct. 27.

Morning topics include: *Acceptable Equipment and Procedures for Evaluating Air Pollution Problems; Environmental Performance Standards: Their Place in Planning and Zoning Regulations; Benefits of Central Gas Cleaning Facilities;* and *How Can We Achieve Better Operation of Dust Control Systems.*

The afternoon roundup includes: *Recent Welding Practices—Naval Facilities; Legal Considerations Involved in Developing Precautionary Labels; A Progress Report on In-Plant Hazard Identification Systems; Recent Developments in Industrial Hygiene (Plasma Jet, Fuel Cell, New Epoxy & Cutting Oils),* and *Some Recent Applications of Glass Cloth Collectors for High Temperature Gases.*

Flying Saucer Air Conditioned

There's many a man who can lay claim to sighting a flying saucer, but only Daniel J. Hunt can boast of air conditioning one! Hunt, a Chrysler Airtemp engineer, recently designed the air conditioning for a flying saucer amusement ride at Freedomland, U.S.A.

However, the saucer, one of many interesting attractions at the $65 million amusement park, is stationary.

As project engineer for the park, one of Hunt's tasks was to plan for 30 tons of air conditioning equipment required for the saucer operation. The saucer has a circumference of 150.8 ft. and an interior of 1,809,056 sq. ft.

Eight bays contain translucent screens, hiding eight movie projectors. Some 230 passengers view the screens which show films of a vertical ascent over 10 cities and on two continents. Center bay area is pressurized by four air conditioners, which eliminate dust from camera's rays, and maintain the effect of a simulated flight.

Electro-Air Program

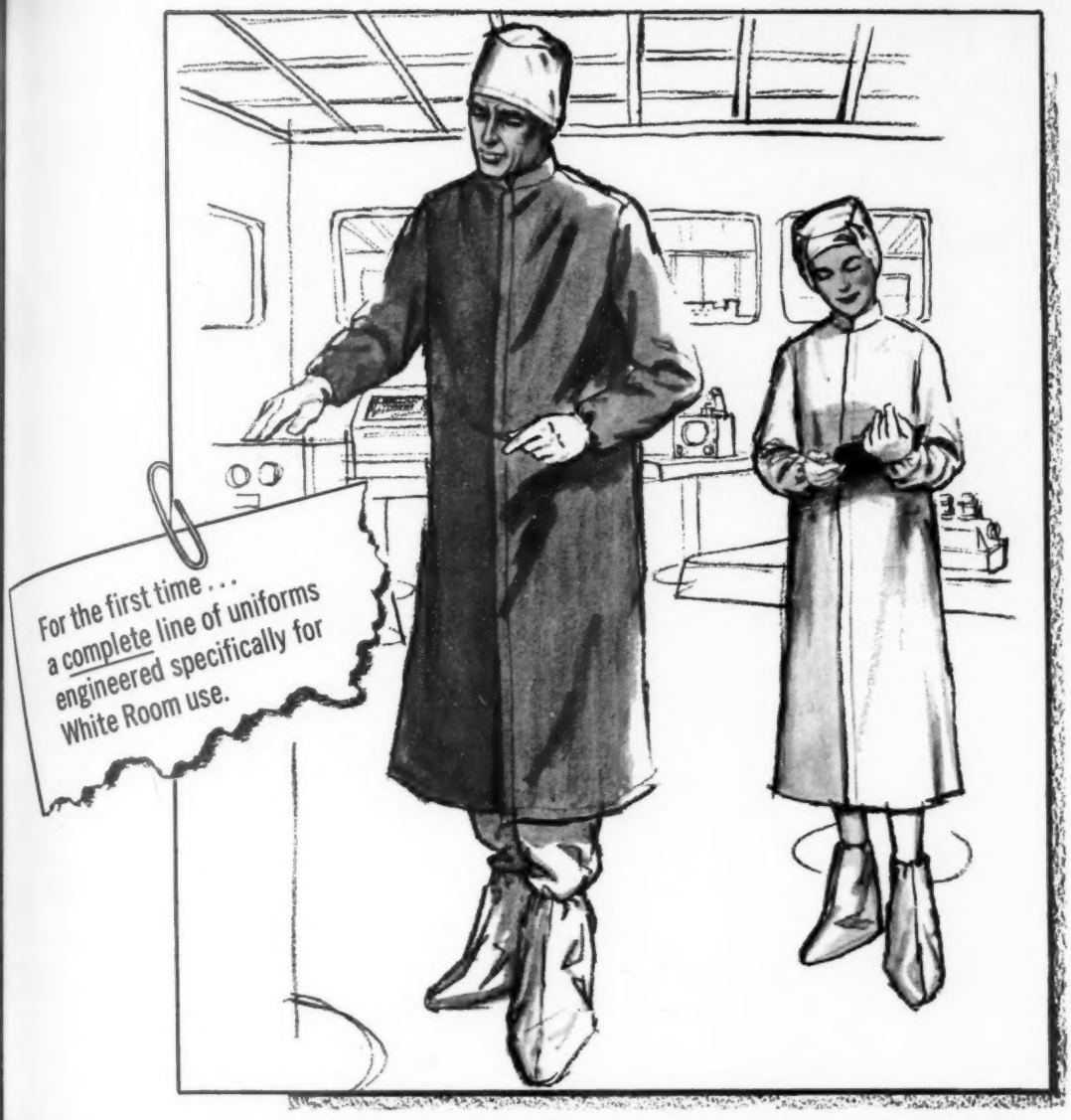
Electro-Air Cleaner Co., Pittsburgh, has launched a quarter-of-a-million dollar expansion program. The company broke ground for a new 26,000 sq. ft. addition to its existing building. This, the company claims, will more than double its present capacity.

City Sells Incinerator Steam

As a business sideline, Chicago will sell by-product steam when it builds its next incinerator. Gross income should be about $4 million. Incinerator, plus equipment to generate steam, costs approximately $7 million.

(Please turn to page 14)

Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, and for comments about any of the editorial material in this issue of AIR ENGINEERING.



LINT-FREE, DUST-PROOF WHITE ROOM APPAREL

designed by FASHION SEAL of TRAVIS' 100% Dacron* Polyester

Fashion Seal, America's leading producer of quality professional and industrial apparel, has long been aware of industry's requirements for the clean room. Because of this need, Fashion Seal has carried on a continuing research program with the single aim of producing the ultimate in lint-free, dust-proof uniforms.

NOTE THESE IMPORTANT FEATURES:

- √ *Lint-Free (100% Dacron* polyester taffeta)*
- √ *No pockets, pleats nor any other dust collectors*
- √ *Seams all double-needled and closed to prevent linting*
- √ *Entire garment sewn with Dacron* polyester thread*
- √ *Offers complete coverage*
- √ *Straight line tailoring resists dust collecting*
- √ *Elastic cuffs protects and prevents lint escape from inner garments*
- √ *Anti-Static finish*
- √ *Washes easily, dries quickly*
- √ *Comfortable, Durable*

All Fashion Seal uniforms can be obtained through your local dealer, jobber, or rented from industrial launderers or linen supply dealers. Whether you purchase or rent, Fashion Seal will be pleased to help you with your uniform problems.

Write to Fashion Seal's Technical Advisory Department for further information and specification sheets.

* DuPont's Polyester Fiber

FASHION SEAL UNIFORMS · 175 FIFTH AVENUE, NEW YORK, N. Y.
LOS ANGELES • PHILADELPHIA • CHICAGO • MIAMI • HOUSTON • CHATTANOOGA

NEWS of the Industry...

(Continued from page 12)

Role of Industrial Hygienist Described by Engineer

The modern plant without any form of dust collection would be an exceptional find, according to Eugene Carsey, assistant chief engineer, Kirk & Blum Manufacturing Co., Cincinnati.

Speaking at the 1960 Industrial Health Conference in Rochester, N.Y., Carsey outlined the role of the Industrial Hygienist in the science of industrial dust collection. The Hygienist, he said, in dealing with health and protective measures, "frequently prescribes the use of exhaust ventilation to provide atmospheric conditions compatible with human endeavor."

The Industrial Hygienist, stated Carsey, is "confronted with several fundamental problems in his diagnosis and analysis, which include:

1. Contaminant source, type and classification
2. Toxicity and allowable limits thereof
3. Remedial ventilation system and its design

Once the first two problems are met with, said Carsey, the Industrial Hygienist then calls upon the air engineer to design a system to meet requirements he has set up.

Speaking of advances in dust collection, Carsey said that ultrasonic aggolomerators, followed by centrifugal separators, is one technique now under study.

Materials used for ductwork, he said, "include nonferrous or stainless steels, aluminum, galvanized steels and irons, certain coated steels and processed paper ductwork. Tile piping and other ceramic type pipe too are very effective in abrasion control," he stated at the Industrial Health Meeting.

Continued From Page 16 —September Issue

Our September News column item *Shell Molding Percentage Up,* page 16, was to have concluded with recommendations by the Michigan Department of Health for controlling dust and solvent vapor exposure. However, these were omitted by oversight, and we are including them in this issue:

1. Provide local exhaust ventilation for sand-conditioning, shell-molding, shell curing, and gluing, pouring, and shake-out procedures.
2. Provide local exhaust ventilation based on solvent-vapor control at sand conditioning where alcohol-resin mixtures are employed.
3. Select safe diluent for silicone parting compounds.
4. Provide good housekeeping program to prevent accumulation of combustible dust.
5. Initiate an effective dermatitis control program as follows:

(a.) All workers and particularly those who come in contact with powdered or liquid resins should practice strict personal hygiene. Readily accessible washing facilities should be provided to facilitate this practice.

(b.) Effective ventilation systems should be provided to minimize skin contact with the resin dust and vapors at all operations, including the curing or bonding operations.

(c.) Personal protection devices, such as cotton gloves and sleeves, provide a satisfactory means of reducing skin contact with the resin and resin vapor materials. The face and the neck can be further protected with water-repellent barrier creams.

(d.) Workmen with active dermatitis should be removed from resin exposure and should be referred to a physician for treatment. After complete recovery these men may be reassigned to the area providing proper protective devices are utilized. They should then be observed carefully for sensitivity reactions and should be removed immediately when indications of this reaction exist.

PHS Creates New AP Division

MacKenzie

Prindle

A new Division of Air Pollution in the Public Health Service has been announced by Surgeon General Leroy E. Burney. The Division is to consolidate research, technical assistance and training activities carried out since 1955 by Air Pollution Engineering and Medical Programs.

Graber

"The division will enhance and facilitate the efforts of the PHS to assist States, Communities and Industry in their research and control activities in this expanding field of nationwide public health concern," Dr. Burney stated.

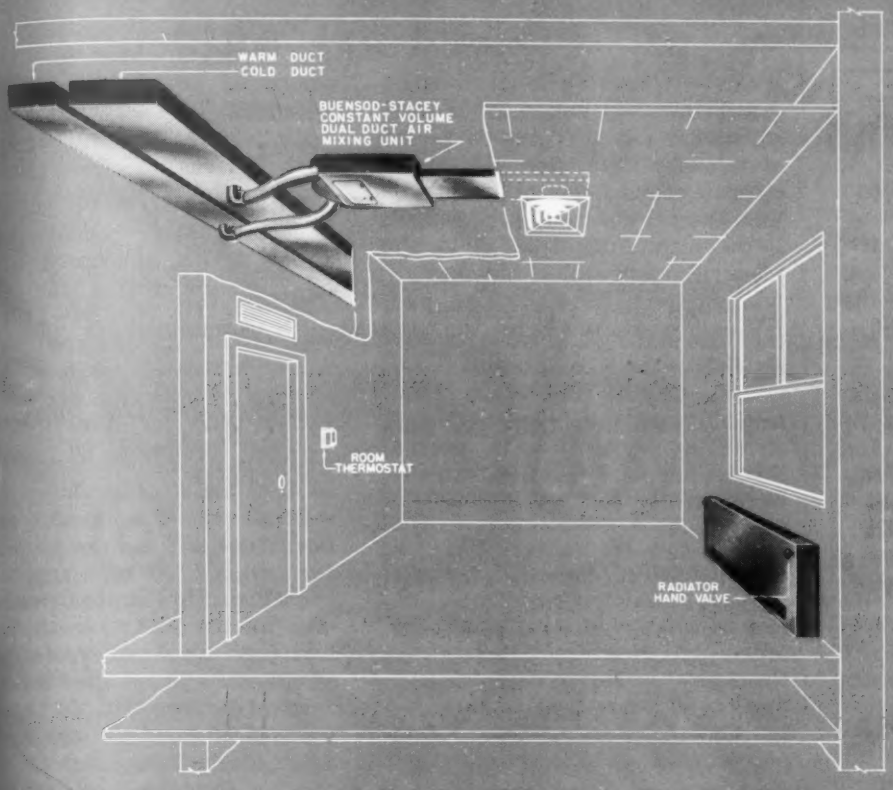
Chief of the Division will be Vernon G. MacKenzie, who is at present assistant chief, Research and Development, Division of Engineering Services. MacKenzie has been active in the field of air pollution for more than 10 years.

Deputy chief will be Dr. Richard A. Prindle, PHS career medical officer and present chief, Air Pollution Engineering Program. Assistant chief of the Division will be Ralph C. Graber, engineer and PHS career officer. He is present chief, Air Pollution Engineering Program.

First U.S. Privately Financed Geothermal Station

The first privately-financed geothermal power station in the U.S., built by Pacific Gas and Electric Co., is now in operation. The station, located at The Geysers, in North-eastern Sonoma County, Calif., consists of a 12,500-kilowatt geothermal facility using natural steam pipelined from the geysers site.

(Please turn to page 16)



NEW DUAL DUCT SYSTEM WITH OLD RADIATION

DUAL DUCT COMPATIBILITY

Adding air conditioning to an existing building need not be a weighty problem. The radiation system generally inherent to this type of structure can simply and economically be augmented by Buensod Dual Duct. Dual Duct is 100% compatible with existing systems. Zones supplied by the old system are given additive ventilation as required and are cooled in warm weather. Newly created zones are completely conditioned for year-'round comfort.

The Dual Duct system is basically a simple one. Hot and cold air is carried at high velocity in separate ducts. Buensod air mixing units in the various zones quietly deliver just the right amount of conditioned air. And exclusive Automatic Volume Control maintains constant air volume regardless of static pressure variation so the system can never be thrown out of balance. Specify Buensod for your next renovation and see how Dual Duct compatibility simplifies your job.

BUENSOD DUAL DUCT

BUENSOD-STACEY CORP., 45 West 18th Street, New York 11, N. Y.

BUENSOD-STACEY

A subsidiary of Aeronca Manufacturing Corporation

NEWS of the Industry . . .

(Continued from page 14)

Air Pollution Legislation

National—A budget of up to $30 million a year for national AP research has been recommended by the U. S. P. H. S. by hired consultants. This is more than double the current $11 million spent annually.

Cleveland — Violation of the city's AP code can bring a 90-day jail sentence. First offenders receive between $25 to $200 in fine, or up to 30 days. Second and subsequent offenses bring $50 to $500 in fines, up to 90 days, or both.

Dayton, Ohio — An agreement, providing technical assistance to the county, on a cost basis, is now in preparation. At present, the city is withholding rigid enforcement of its clean-air ordinance because of the absence of enforcement outside the city limits.

Denver—Senator Ranger Rogers, Senate minority leader, urged state legislation in the metropolitan area, and stated he would recommend a central regional authority with the power to make AP inspections.

Fresno, Calif. — The November ballot will carry a proposition for the formation of a smog control district in the San Joaquin Valley. County Counsel Robert M. Wash has informed the Board of Supervisors a proposition is needed. But, as late as August, supervisors were neither for nor against the suggestion.

Jacksonville, Fla.—AP commission reports, once kept secret, are now available to the public, by order of commission members. Previous reports, concerning volume of fluoride pollution caused by phosphate industries in Polk and Hillsborough Counties, did not pinpoint locations where concentrations occurred.

Florida's AP Commission is asking legislature for $224,740 for operating costs during the next biennium. This is twice the amount appropriated by the last Legislature.

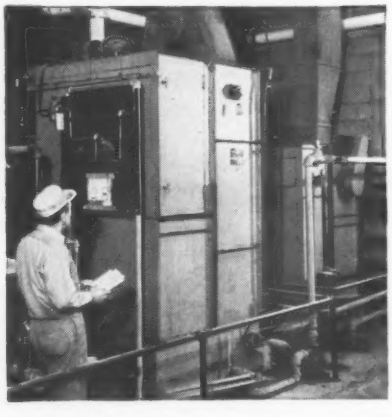
Massachusetts — Dr. Alfred L. Frechette, state commissioner of public health, announced adoption of minimum regulations to prevent AP. Dr. Frechette said new regulations are designed for use when relatively isolated single sources of pollution are involved, rather than for control of more general problems of cities or metropolitan areas.

Pittsburgh — A smoke control law, described as "the toughest in the nation," has been approved by the Allegheny County Commissioners. Specific limits are set, for the first time, on stack emissions from steel plants and related industries. Ordinance provides for appointment of 15-man advisory group to assist in drafting time tables, as the law fixes no compliance deadlines. New ordinance replaces 1949 law.

DRY and CLEAN AIR at the RIGHT TEMPERATURE

- to control your product quality
- to protect a critical operation
- to protect apparatus from moisture damage
- to DRY your material or product
- to control packing or storage conditions
- to assure precision in testing or research
- to increase air conditioning capacity

Air Condition by the NIAGARA Method Using HYGROL Liquid Absorbent



This compact method, giving high capacity in small space, removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the air.

Most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result, and always. Niagara machines using liquid contact means of drying air have given over 20 years of service. The apparatus is simple, parts are accessible, controls are trustworthy.

Most reliable because...the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

Most flexible because...you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Write for Bulletins 112 and 131 and complete information on your air conditioning problem.

NIAGARA BLOWER COMPANY

Dept. AIR-10, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

Super-Clean Room Seminar Nov. 1

There will be an interesting seminar on Super-Clean Rooms (White Rooms) at Arizona State University, Tempe, Arizona (near Phoenix), on Tuesday, Nov. 1. The all-day session will present current data on White Room Design, Construction, Air Filtration, Problems and Solutions.

Speakers include:

A. Baker, Baker Instruments Co., Chandler, Arizona.

James Mildon, chief plant engineer, Lear, Inc., Grand Rapids, Mich., on New Criteria For White Room Design.

V. Freeman, Litton Industries, slide and discussion on this electronic tube firm's White Rooms.

E. Casey and W. Jerome, North American Aviation's Rocketdyne and Autonetics Divisions, respectively. Discussion, film and slides on their White Rooms.

Evening sessions will include a Q&A period and bull session on Seminar participant's own White Room problems.

For more information, write Chris Gort, plant engineer, Sperry Gyroscope Co., Phoenix, Arizona.

Monitoring System Proves Indispensable Tool

American Cyanamid Company has found that an air pollution monitoring system begun five years ago at its Brewster, Florida, phosphate plant has been an indispensable tool in determining control measures necessary for maximum production without air pollution. Additionally, the project has helped improve the plant's community relations.

So reported Charles R. McHenry, an industrial hygienist in Cyanamid's central medical department, in a paper delivered to members of the Air Pollution Control Association at its annual convention in Cincinnati.

He described the unique procedures initiated in 1956 when Cyanamid decided to build a triple superphosphate facility in an expansion of its Brewster operations.

Cyanamid's approach to ensure reduction of fluoride emission consists of three phases:

First: incorporation of certain engineering controls in the blue print specifications of the new plant.

Second: undertaking a five-year environmental study still in progress, that includes continuous monitoring of fluoride content of air and water, soil samples and vegetation, and collection of meteorological data. This study, begun one year before the triple plant went into production, is being used to determine the efficacy of initial controls and the need for additional controls.

Third: final evaluation of data obtained by monitoring, which will be made available to industry, government and other specialists concerned with air pollution.

Cyanamid's comprehensive monitoring program is regarded as the most extensive undertaken in the phosphate industry. For example, in carrying on atmospheric sampling, four continuous and dynamic sampling stations and 18 static sampling stations are located at distances up to 20 miles from the plant, Mr. McHenry reported. A complete meteorological monitoring station was also set up.

Mr. McHenry described various methods of sampling, including laboratory evaluation of vegetation and streams in the area.

Studies have been used to determine a fluoride emission rate consistent with regulations set by the Florida Air Pollution Control Commission. Additional control equipment is being installed to accomplish this, said McHenry.

Cyanamid to date has spent more than $1,400,000 in studying and effecting air pollution control, it was stated.

Fog & Fumes Trouble

Fog and fumes of unknown plant origin recently created problems in Plant City, Fla. Patients and staff at South Florida Baptist Hospital suffered from burning eyes and throats, severe coughing and choking spells. Traffic was snarled and accidents occurred.

Phosphate engineers and laboratory men thought that sulphur dioxide was among the fumes released by a nearby acid plant. These fumes, being heavier, drift downward. Which plant to blame puzzled authorities.

INCINERATION
WITH
Air Pollution Control
MORSE BOULGER INC.
BUILDERS OF THE MOST MODERN INCINERATOR PLANTS IN THE WORLD

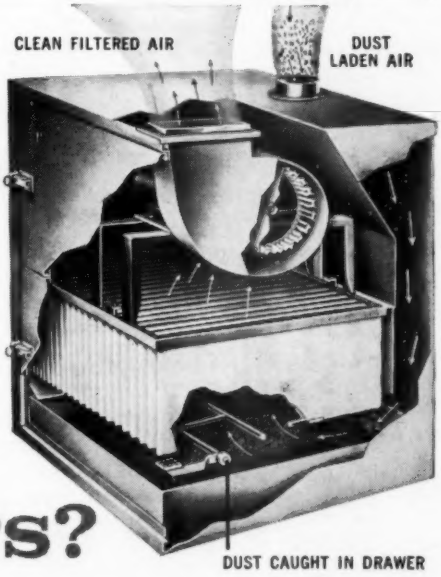
FREE
Incinerator Facts
☐ Municipal Bulletin 111-C
☐ Industrial Bulletin 184-A

Contact us, or have your architect or consulting engineer tap our 70 years experience solving Waste Disposal problems—large or small. No obligation.

MORSE BOULGER INC.
80 FIFTH AVENUE, NEW YORK 11, N. Y. Dept. 17
Representatives Everywhere
Member: Incinerator Institute of America, Air Pollution Control Assoc.

have you got the facts on money-saving preventive maintenance with

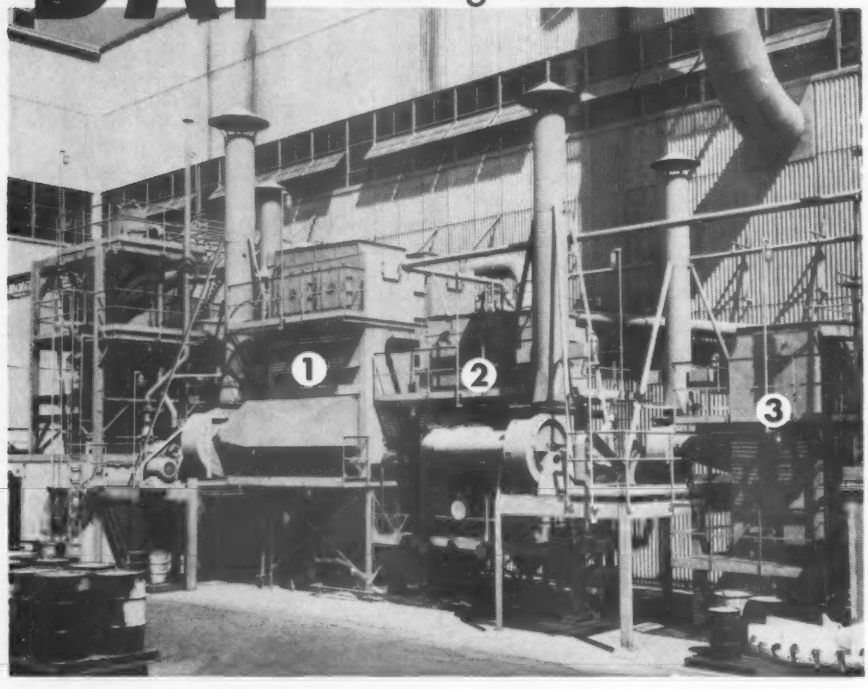
Torit dust collectors?



Clean machines hold close tolerances *better* and *up to 80% longer*. Result: a measurable saving in both the cost and frequency of servicing and maintenance work. You can protect your client's plant and equipment investment, help reduce potential production breakdowns, by specifying TORIT Dust Collectors. In the cabinet type (illustrated by cutaway drawing) filters are rated 99.99% efficient by weight on particles as small as ½ micron! Compact Torit high efficiency cyclone and cabinet type units are designed to save space, install anywhere. Your Torit representative will gladly give you dust collector specifications, performance charts, dimensional drawings and installation suggestions. Write:

TORIT MANUFACTURING CO.
1133 Rankin Street • St. Paul 16, Minn. • Dept. 1917

DAY *plant proven dust control filtering URANIUM dust*



3 DAY "AC" Dust Filters Serve MALLINCKRODT CHEMICAL WORKS

URANIUM DIVISION, AEC Weldon Springs Site

Shown above are 3 DAY "AC" dust filters. Filters No. 1 and 2 are collecting magnesium fluoride (M_gF_2) slag dust and U_3O_8 from slag grinding and similar operations. Filter No. 3, on the right, serves to filter uranium tetrafluoride (UF_4).

Equipment with high filtering efficiency is an imperative requirement for an installation of this type. These DAY filters meet this requirement. They capture sub-micron particles with 99.99+% efficiency because they are designed around the Hersey principle of air filtration which uses felted filter media. Filter media porosity is maintained automatically and continuously by high velocity reverse jet air. This assures stable back pressure.

Throughout many industries DAY equipment is preferred because it's *plant proven*. It means DAY not only offers high efficiency and pure, clean air but higher recovery of valuable product. DAY "AC" reverse jet filters are also preferred because they occupy a minimum of space and provide higher air handling capacities (4 to 5 times higher than non-reverse-jet type filters).

For more facts about the services and equipment DAY offers, consult your DAY application engineer, and for complete facts about DAY filters write toDAY for Bulletins F-75 and G-579. They contain helpful planning information and air engineering data.

The DAY *Company*

SOLD in UNITED STATES by
The DAY SALES Company
868 Third Avenue N.E.
Minneapolis 13, Minnesota

DAY SINCE 1881

MADE and SOLD in CANADA by
The DAY Company of Canada Limited
Rexdale (Toronto), Ontario, Canada
Fort William, Ontario, Canada

Representatives in Principal Cities

EXPERIENCE ENGINEERED . . . LABORATORY TESTED . . . PLANT PROVEN
Dust Control • Pneumatic Conveying • Bulk Storage
EQUIPMENT . . . SYSTEMS . . . INSTALLATION

Complaint$

Chicago—Judge E. Geary found the General Iron Industries, Inc. guilty of smoke violations and fined the firm $100 and $20 costs. The firm escaped the $400 maximum fine when its attorneys told the court it is building an incinerator to prevent further violations.

• • •

Kansas City, Mo. — Northeast and Intercity district residents threatened court action for relief from odors allegedly emanating from a Chemagro corporation plant. Herbert F. Tomasek, president of the firm, is turning to the Midwest Research Institute for assistance.

"This problem cannot be solved by condemning merely Chemagro," Tomasek stated. "We have reason to believe there are other offenders and we are not going to pay the bill for them."

• • •

Erie, Pa.—Corrective action has been taken to eliminate smoke pollution emanating from the Hammermill Paper Co. Hammermill outlined major steps for reduction of its air pollution.

In the future, the plant will no longer burn its wood bark in the plant incinerator or at dump sites, but will use it for power plant fuel. This action will free the incinerator for use in burning air polluting combustibles.

• • •

Newport, Oregon — Odor complaints have been reported by the Newport Tourist Assn. to the state Sanitation Dept. The Association insists that a "strong and offensive odor" is turning visitors away and keeping motel owners from business.

A question exists as to the source of the odor. The Association letter states, "Whatever the source, whether it be Georgia-Pacific [object of a July odor complaint] effluent or sewage or both . . . the condition remains."

• • •

Stamford, Conn. — Tables are turned as industry sets somewhat of a precedence by making an air pollution complaint to city officials. Karl Illigen, vice president of Northam Warren Corp., wrote complaining about alleged nuisance created by another industry located near his firm's plant.

Complaint has brought about study of city's air pollution problem.

New Literature

Heat Exchanger Brochure

● Brochure describes manufacturer's "air to air" heat exchanger designed to recover heat from contaminated exhaust air or cool incoming air into refrigerated spaces.

Source: *Heat Recovery Corp., 571 Mt. Prospect, Newark 4, N. J.*

Terminal Control Unit Catalog

● Detailed, 36-page, description of manufacturer's new line of acoustic terminal control units for all-air high-velocity systems, provides information and data on three ceiling and two window/perimeter models. Other data include new tables of static-pressure losses and regains, material on system noise.

Source: *Carnes Corp., Verona, Wisc. (Catalog No. 1060.)*

Ilg Bulletin and Catalog

● Bulletin DB1-106 lists information on heavy-duty, square panel, self-cooling propeller fans. Rating tables are given for fans with constant and 2-speed, 1- and 3-phase motors together with data on decibel rating, sound class, cfm output, weights and specific dimensions. Catalog DB1-100 lists data on self-cooled motor propeller fans, with space devoted to accessories, wall and ceiling ventilators, cooling and circulating fans.

Source: *Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago.*

Anchor Wall Chart, Leaflet, Catalog

● Two-color wall chart, 21 in. x 32 in., of use to fluid power users, lists data on Anchor line of replacement hydraulic hose, couplings and fittings products. Envelope-size, 10-page leaflet, lists highlights of aforementioned products. Catalog No. D-1, 24 pages, gives specifications and installation data on products.

Source: *Anchor Coupling Co., Inc., 342 North Fourth Street, Libertyville, Ill.*

Doerr "Idea Book" and Catalog

● Condensed catalog gives construction, dimensional and price data on manufacturer's line of fractional and integral horsepower motors, with practical ways of solving special job problems. Illustrated, 14 pages.

Source: *Doerr Electrical Corp., 100 N. Fourth Ave., Cedarburg, Wisc.*

Comfort Conditioning With Light and Air

● A 24-page catalog with factual information on the history and evolution of lighting and air distribution, combined with data for selecting and predicting performance, as well as drawings illustrating how new combination light and air diffusers are installed and balanced.

Source: *Barber-Colman Co., Rockford, Ill. (Catalog F 9768).*

Engineering Research Review

● Bi-monthly publication, with current issue devoted to a survey of research in air and water pollution made by Research Division of New York University's College of Engineering. The 16-page, illustrated booklet is divided into sections dealing with aerodynamics, meteorology, sanitary engineering, combustion processes and industrial medicine. Twenty photographs.

Source: *Office of Information Services, New York University, University Heights, New York 53.*

Air Diffuser Bulletin

● Illustrated, 12-page bulletin describes manufacturer's linear and rectangular series air diffusers (square, panel, long-slotted), with selection and performance data.

Source: *Connor Engineering Corp., Dept. K-D, Danbury, Conn.*

Felt Insulation Bulletin

● Baldwin-Ehret-Hill has prepared a technical bulletin describing the complete thermal and acoustical characteristics of their felt insulation product.

Source: *Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J. Bulletin J-661.*

Conveying Systems Bulletin

● A 16-page bulletin illustrating and explaining efficiency gains possible with manufacturer's low or high density conveying systems. Typical arrangements are shown, as well as several installation photographs.

Source: *Day Co., 810 N.E. Third Ave., Minneapolis.*

New Electromode Catalog

● The Electromode Division of Commercial Controls Corp., has prepared a new catalog of unit heaters, thermostats, manual switches, contactors and percentage timers.

Source: *Electromode, P.O. Box 1052, Rochester 3, New York.*

Flexible Tubing Manual

● Methods for handling air, liquids and light solids with nonmetallic flexible tubing are now available in manual form. Called "The Facts About Flexible Tubing," the manual provides a full description of the varied forms, major advantages and uses of flexible tubing.

Source: *Flexible Tubing Corp., Guilford 2, Conn.*

Centrifugal Fan Catalog

● Simultaneous with the appearance of Westinghouse's new line of "Centriline" airfoil centrifugal fans, is Catalog 1125 which lists features, accessories, dimensions, and other pertinent data on unit performance.

Source: *Westinghouse Electric Corp., Sturtevant Division, Hyde Park, Boston 36.*

1959 Engineering Index

● The 1959 Engineering Index, a composite guide to world periodical technical literature, is now available at $70 post paid. Included in the 1636-page volume are over 34,000 abstracts, covering 1600 technical periodicals from 44 countries, 249 "field of interest" divisions, and a 96-page author's index.

Source: *The Engineering Index, 29 W. 39th St., New York 18, N. Y.*

Dust and Fumes Guide

● The British Ministry of Labour recently issued "Toxic Substances in Factory Atmosphere," a booklet dealing with measures for the protection of workers against the inhalation dusts, fumes and other impurities.

New PRODUCTS

High Velocity Induction School Ventilating System

Purpose: To provide a less costly method of heating and ventilating schools.

Features: According to manufacturer, the system operates on the principle of high velocity induction, and said to reduce heating and ventilating costs as much as 10 percent. Similar to forced warm air systems found in homes, differing, however, in that more air is circulated and each outlet contains a coil for reheating room air induced through it.

The reheat coils acts like a baseboard convector at night and during weekends, reducing operating costs by eliminating the need to send warm air into the rooms from the central system during these periods.

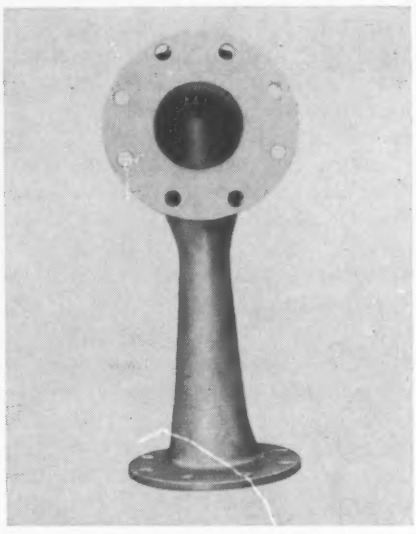
Source: Carrier Corp., Dept. AE, Syracuse 1, N. Y.

Vertical Discharge Air Intake Units

Purpose: For use in replacing air removed by the operation of exhaust pipe systems.

Features: Low silhouette, blackout type roof ventilator fan housing permits addition of shutters, steam coil, filter house and outlet diffusers as needed. Four basic units give capacity range of from 4,000 to 36,000 cfm. Where tempered air is required and a steam coil used, Btu capacity (at 5 lbs steam pressure) ranges from 380,000 to 2,642,000 Btuh.

Source: Hartzell Propeller Fan Co., Piqua, Ohio.

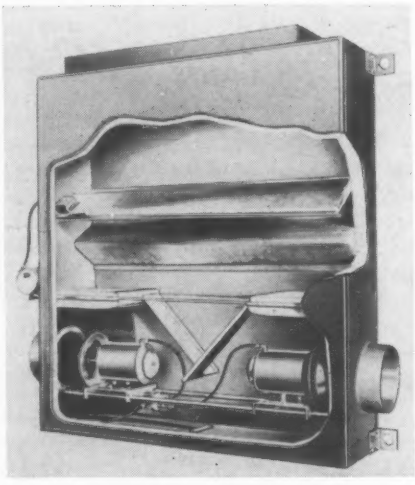


Ejector-Venturi Scrubbers

Purpose: To move large quantities of air and gas at low draft, while providing interior and exterior corrosion resistance.

Features: Claimed to effectively remove dust and particulate matter as well as obnoxious vapors and corrosive gases. Made of reinforced resin bonded fiberglass construction. Resistant to most acids and other non-oxidizing materials. Effectively used at temperatures approaching 300°F.

Source: Du Verre Inc., Dept. AE, P.O. Box 37, Arcade, N. Y.



Acoustic Terminal Control Units

Purpose: To provide acoustical terminal control for all-air, high-velocity systems.

Features: Units said to be designed to solve service problems by eliminating curtains, linkages, flappers, pulleys, sliding bases, bladders, cables, pivots, perforated follow-through plates, and split responsibility in servicing the units.

Claimed by manufacturer to: (a) reduce high velocities and pressures for discharge of air at conventional low velocity values; (b) proportion hot and cold flows in response to room thermostat; (c) mix hot and cold flows to provide uniform temperature at discharge; (d) attenuate self-generated noise and duct airborne noise; and (e) automatically control volume of air discharge despite static pressure unbalance (or provide manual volume control).

Units available in three ceiling and two window/perimeter models. Ceiling models in six sizes, window/perimeter in three.

Source: Carnes Corp., Dept. AE, Verona, Wis.

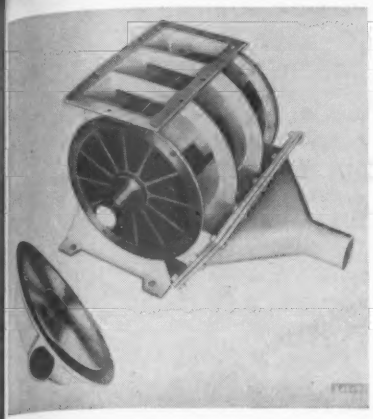
Elliptical Air Discharge Valve

Purpose: To permit handling of coarse abrasives, catalysts, pellets, and odd shaped materials unable to pass through conventional rotary valves.

Features: Valve's elliptical body and "sandwiching" of sheet rubber diaphragms are said to insure positive closure. Movement confined to gum rubber diaphragms which alternately open and close by air pressure or vacuum. Action permits discharge of materials in measured quantities with air tight seal.

No internal wearing metallic parts . . . rubber diaphragms are easily replaced.

Source: U.S. Hoffman Machinery Corp., Air Appliance Division, Dept. EJM (AE), 103 Fourth Ave., New York 3.

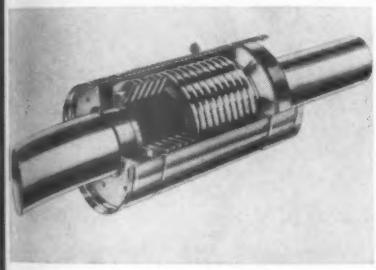


"Air Swept" Feeder

Purpose: To eliminate bearing trouble caused by pneumatic conveying of certain products.

Features: High pressure filtered air enters hollow end bells on each end of feeder and enters feeder pockets near discharge point. Double inlet action is said to thoroughly mix air with product being conveyed, sweeping pockets clean and increasing volumetric efficiency. Air chambers keep blanket of air between product and bearings.

Source: Day Co., Dept. AE, 810 N.E. Third Ave., Minneapolis 13.



Hot Water & Steam Heat Expansion Joints

Purpose: For hot water and steam heating installation on straight baseboard runs of 25 ft or more (water temperatures ranging from 100° to 250°F).

Features: Expansion joints have large bronze bellows with copper tubing electronically welded at each end for sweat connections. Two large sized laminated fiber rings are provided to "assure a completely water-tight unit." Bellows and disc assembly are encased in sturdy brass protective cover, made with integral limit rings for maximum and minimum positions. Recommended maximum pressure for hot water is 45 psi, for steam applications, 15 psi.

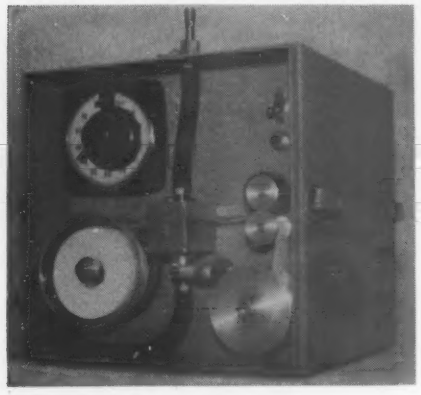
Source: Modine Mfg. Co., Dept. AE, 1500 DeKoven Ave., Racine, Wis.

(Please turn to following page)

Research
Responsibility
Results
WHEREVER GASES ARE
CLEANED OR HANDLED.
Aerotec Industries offers more than a half century of world wide experience in engineering and manufacturing equipment for efficient and economical cleaning and handling of air and gas. Single responsibility for complete systems, from design to final installation, assures management that overall performance guarantees will be met. Write for information on the products of interest.
AEROTEC INDUSTRIES
INCORPORATED
EXECUTIVE OFFICES • GREENWICH, CONN.
Plants at Bantam, Greenwich and So. Norwalk, Conn.
Canadian Affiliate: T. C. CHOWN LIMITED, Montreal and Toronto
Divisions: INDUSTRIAL • Electrical and Mechanical Dust Collectors • Wet Collectors • Fans • Fan-Stacks • Blowers • Gas Scrubbers • Air Preheaters • Curtain Dampers.
AIRCRAFT EQUIPMENT • Advanced electro-mechanical equipment for the aircraft, missile and nuclear industries.
AEROTHERM • Aircraft lounges, passenger and crew seating.

New PRODUCTS

(Continued from preceding page)

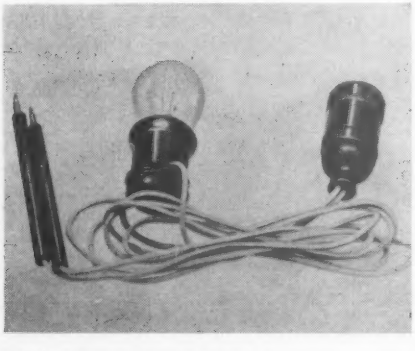


Automatic Air Sampler

Purpose: For automatic collection of air samplings.

Features: Unattended, periodic advancement of tape provides permanent air pollution record for subsequent analysis. Works by drawing air samples through the paper tape at approximately 14 liters per minute. Accessories include facility to measure amounts of dust or aerosols in air, an optional evaluator to determine gas levels, and a scintillation or Geiger counter for monitoring radioactive particle content in air. Measures 9 in. x 9 in., weight: 20 lbs.

Source: Gelman Inst. Co., Dept. AE, Box 86, Chelsea, Mich.

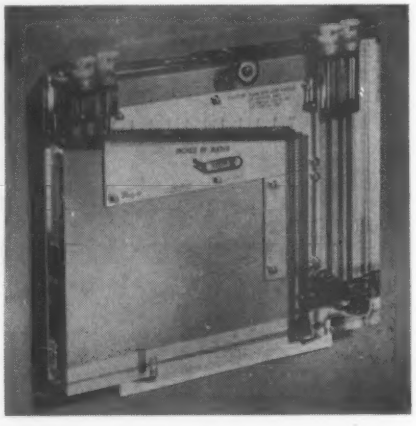


Refrigeration Circuit Continuity Checker

Purpose: Inexpensive continuity checker used as refrigeration service tool.

Features: Test lamp includes 230v bulb, can be used on both 230 and 110v circuits. Twin probes are placed on circuit to be checked; if bulb glows, circuit is complete, if not, circuit contains a break.

Source: Robnair Mfg. Corp., Dept. AE, Montpelier, Ohio.



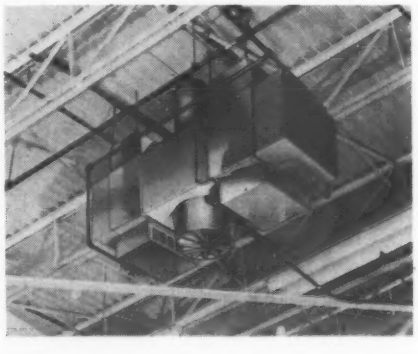
Inclined-Vertical Manometers

Purpose: Instrument designed for use with pitot tubes and in flow measurement.

Features: Available in single or double columns styles, stationary or portable, various ranges up to 23 in. of water. Said to be accurate within plus or minus 1 percent. Fixed scales are polished chromium, permitting accurate alignment of the fluid meniscus with its image to eliminate parallax error.

Split aluminum inserts and machine screws hold scales and other accessories securely to instrument, eliminating stripped threads or damage to plastic.

Source: F. W. Dwyer Mfg. Co., Dept. AE, AG-8, P.O. Box 373, Michigan City, Ind.



Industrial Vertical Discharge Units

Purpose: New line of vertical discharge unit heaters for industrial application.

Features: Designed for installation at heights of 36 ft. High heating capacities of 300,000; 450,000; 600,000 Btuh input, with weight of 383 to 680 pounds. Motors range in size from ½ to 1 hp. Burners are stainless steel and heat exchangers are either stainless or aluminized steel. Duct furnaces used in building these units are A.G.A. approved.

Manufacturer reports units deliver large volumes of air at high velocities and comfortable final air temperatures, even when installed above craneways and other plant equipment.

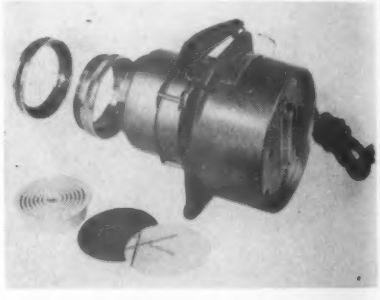
Source: Modine Mfg. Co., Dept. AE, Racine, Wis.

New Dual-Density Duct Liner

Purpose: To check air erosion, cut noise, and improve insulating efficiency.

Features: Material is resilient, semi-rigid blanket-type insulation composed of strong, fine inorganic glass fiber bonded by a thermosetting resin to form two different densities of insulation.

Source: Johns-Manville, Dept. AE, 22 East 40th St., New York 16, N. Y.



Large Volume Air Sampler

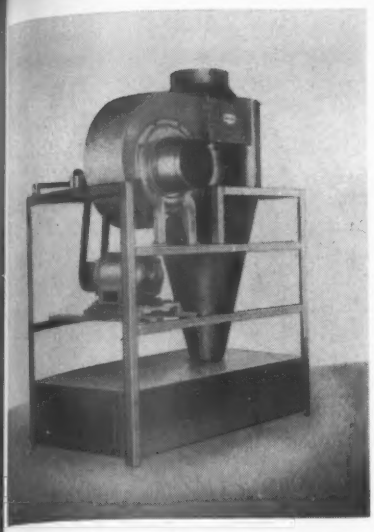
Purpose: For sampling large volumes of air for particles as small as 1/100th of a micron in diameter.

Features: Unit employs turbine type blower. Permits use of filter paper of approximately 4 in. diameter. Filter holder accommodates both pleated and flat papers. When using flat filter, removable cross-grid is inserted behind paper to prevent rupture in service.

Portable housing assembly is cast aluminum, weighs 10 lbs. Flow rate is measured by means of indirect, variable orifice meter. Air mover is high speed, heavy-duty pump and motor, .49 hp; 15,600 rpm, for 24 hour sampling.

Source: Staplex Co., Dept. AE, Air Sampler Division, 777 Fifth Ave., Brooklyn 32.

Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, etc.

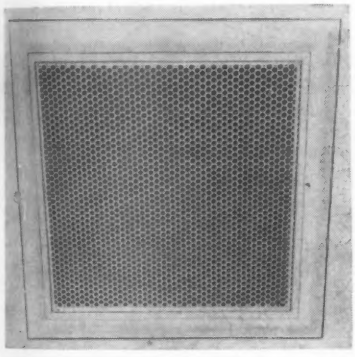


Large Volume Dust Collector

Purpose: For collection of dust where large volumes of air are required.

Features: Modification of stack and addition of air control disc, which increases the flow of air through the cyclone separator, is said to be a recent improvement in manufacturer's series.

Source: Aget Mfg. Co., Dept. AE, Adrian, Mich.



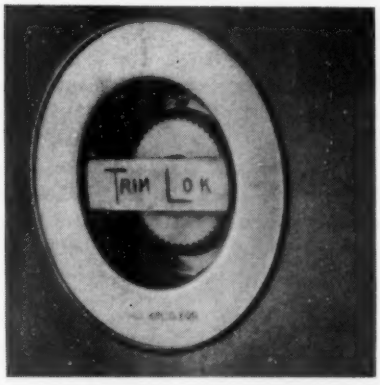
Supply & Return Ceiling Diffusers

Purpose: To conceal air diffusion mechanism and blend into acoustical ceiling tile.

Features: Supply and return diffusers are available in square and rectangular models, in one-, two-, three-, and four-way air patterns. Two basic types: one for surface mounting on any type ceiling, another for recessed mounting on acoustical tile ceilings. Models for surface mounting are available with curved or flat border.

Models for recessed mounting have a border that snaps into standard tile or can be used with T-bar construction. Finish is of white baked enamel. Accessories include blade damper, volume controller and volume extractor controller.

Source: Titus Mfg. Corp., Dept. AE, Waterloo, Iowa.



Duct, Plenum, Ceiling Damper Regulator

Purpose: For installation on ducts, plenums, and ceilings as a damper regulator.

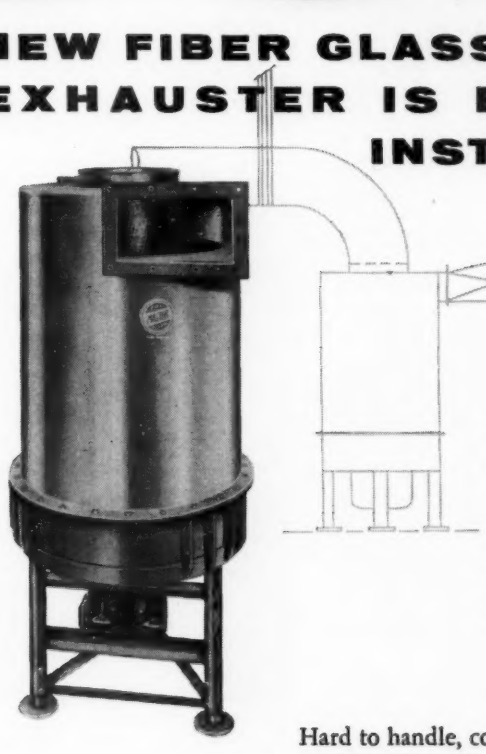
Features: Manufacturer claims "Trim-Lok" offers a positive locked damper and integral flange for insulation trim. Used to set manual dampers in any desired position. Made of rustproof 24-gauge steel, outside diameter of flange is 6 5/16 in. and depth of unit is 1 in.

Attachment is by means of three sheet metal screws. The device is

(Please turn to following page)

Goodbye to Plant Fumes!

• NEW FIBER GLASS FUME EXHAUSTER IS EASILY INSTALLED!



A simple, self-contained unit that is easily installed. Requires a minimum of space and maintenance. Shipped ready to connect to ductwork, water supply, and drain.

Hard to handle, corrosive fumes are *easily dissipated* by this dependable Master Lip-type FUME EXHAUSTER FIBERGLASS UNIT. Capacities from 1500 to 12000 C.F.M. Maximum air movement plus quiet, vibration-free operation, long life, and low operating cost. **Carbon steel and plastisol lined Fume Exhausters, also, are available.**

MASTER FAN CORP.

1323 CHANNING STREET LOS ANGELES 21, CALIF. MAdison 2-1037

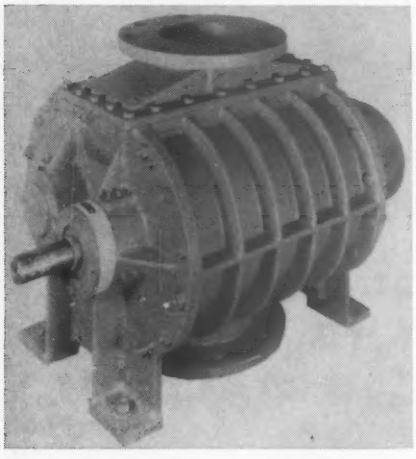
Serving Western Industry for over 40 years.

(Continued from preceding page)

for use with 1-in. insulation and metal spacers are available for use with 1½ and 1-in. insulation.

Manufacturer reports, ". . . damper blade regulated by Trim-Lok is installed parallel with handle, which visually indicates the exact position of damper at all times."

Source: Rinco, Dept. AE, P.O. Box 453, Altadena, Calif.



New Rotary Blower Supplement

Purpose: Offered by manufacturer as a supplement to regular series. Claimed to provide higher-than-standard maximum speeds and greater output.

Features: New additions include a thrust bearing kit on the drive shaft, steel gears and dynamically balanced impellers. Thrust bearing kit is new design and fits over drive shaft in position formerly occupied by drive bearing cover plate. Thrust kit locks axial movement of shaft, preventing impeller rub against headplate.

Impellers are pressed and keyed securely to the shaft and said to operate without vibration. Rotary unit acts on principle of positive displacement of air or gas by impellers which rotate in opposing directions to deliver a metered volume for each revolution.

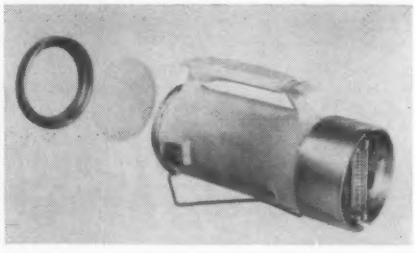
Impellers are separated by minute clearances which are controlled by timing gears. Units in 2 in. through 8 in. gear diameters.

Source: Sutorbilt Corp., Dept. AE, Compton, Calif.

High Volume Air Sampler

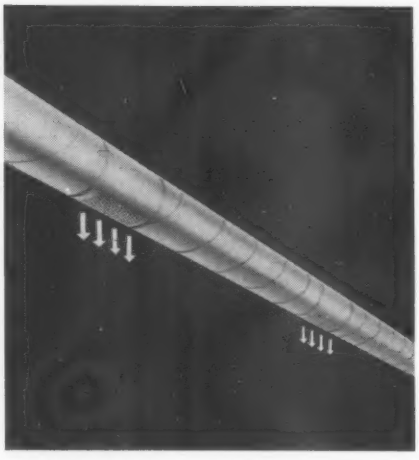
Purpose: For use in sampling high volume air.

Features: Developed and tested by New York office of the Atomic Energy Commission, Health and Safety Laboratory. Ran 427 continuous hours using a 4 in. diameter Whatman-41 filter paper. Unit reported not to have overheated . . . motor not damaged, and, at end of continuous run, brushes were replaced and operation repeated. Made of high impact styrene. End mounts are machined of aluminum.



Filter holder is one-piece machined ring, with paper sealed by means of an O-ring attached to the body of the pump. Flow rate measured by means of an indirect variable orifice. Price: $75.

Source: Union Industrial Equipment Corp., Dept. AE, Port Chester, N. Y.



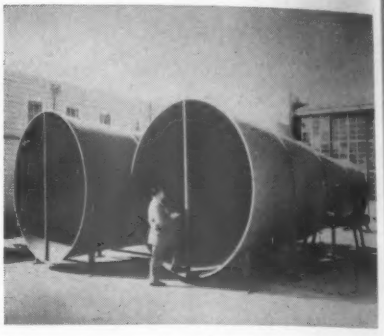
Spiral Pipe Duct-D-Fuser

Purpose: To provide air distribution from round ducts, without the use of special fittings or duct attachments.

Features: Claimed to be installed in duct runs as easily as a coupling. Operates in high, medium or low pressure systems, without pressure valves or directional vanes. Shaped nozzles provide planned air distribution directly from round duct. Permits full flow of main body of air.

Model *F* with fixed position contains sliding damper for volume control without affecting diffusion angle. Model *R* may be rotated to change direction of air pattern without disturbing duct. Model *S* has 360° diffusion pattern around circumference. Type *CP* is custom pattern placement of nozzles for special air distribution.

Source: United Sheet Metal Co., Inc., Dept. AE, 540 South Drexel Ave., Columbus 9, Ohio.



New Line Axial Flow Blowers

Purpose: For use in heating, ventilating and air conditioning industries.

Features: Blowers will handle from 1,000 cfm to over 500,000 cfm with pressures from atmospheric to 10 in. of water static pressure with single stage units. Sizes up to 12 in. diameter. Fixed blade design from 14 in. to 120 in. diameter in patented blade retention designs.

Standard hub diameters available from 14 in. to 40 in. Engineered drives available for this equipment include belt, coupling or direct drive.

Source: Benson Mfg. Co., Commercial Blower Division, Dept. AE, Kansas City 27, Mo.

Duct-Type Ion Generator

Purpose: To produce negative ions for circulation through heating and air conditioning ducts to residential, commercial and industrial spaces.

Features: Non-metallic generator produces ultra violet rays without hot sparks, direct arc or heat to ionize air. Humidity control device is said to dehumidify air as it passes through the equipment, keeping generator dry at all times.

Sizes from 300 to 3,000 cfm. Portable units plug into standard wall outlets and have a self-contained circulator.

Source: Vita-Aire Process Co., Inc., Dept. AE, 1736 North 2nd St., Milwaukee 12, Wisc.

Pyrometric Temperature Indicator

Purpose: Designed for use on ovens, heat treating furnaces, environmental test chambers, die casting machines, injection molding machines, extrusion presses, heat sealing machines, and many processes requiring precise continuous control.

Features: Instrument case size (6-3/8 in. x 7 in.) makes it a desirable panel board instrument. Indicator and controller is available in 11 ranges from 0-400°F to 0-3000°F, as well as an environmental test chamber range of -100° to +300°.

Source: Alnor Instrument Co., Division of Illinois Testing Laboratories, Inc., Dept. AE, 418 N. LaSalle St., Chicago 10, Ill.

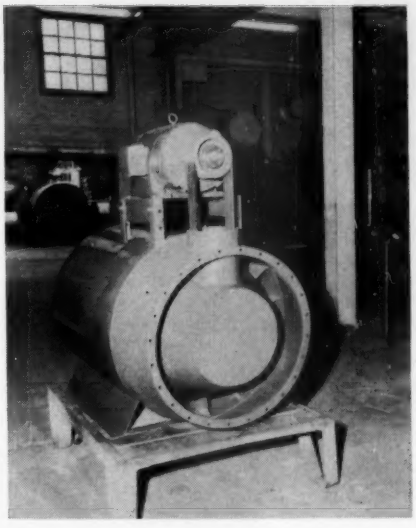
Straight-line Flow Centrifugal Fan

Purpose: To reduce air conditioning and air handling fan installations space by less than one-half.

Features: Said to combine advantages of airfoil-bladed centrifugal fan performance with space-saving features of straight-line air flow. Exterior shape of "Centriline" fan resembles axial fan, but is definitely of the centrifugal type.

Newly-developed aerodynamic conversion vanes contribute to minimization of noise. Available in six sizes, with airfoil wheels from 27 to 44½ in. diameter, all of unobstructed design with no intermediate rings or stay rods.

Heavy steel all-welded casing rigidly braced and allows for two types of mounting: (1) with motor base right on the fan housing, and (2) with motor mounted separately on an integral vibration base. Inlet and outlet dimensions are the same, one size duct may be used.



Source: Westinghouse Electric Corp., Sturtevant Division, Dept. AE, Hyde Park, Boston 36.

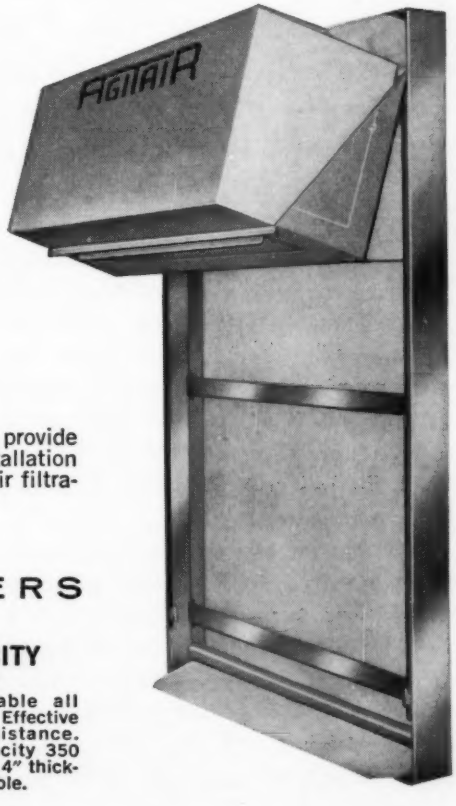
Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, etc.

AGITAIR®

PULL DOWN FILTERS

TYPE 'DS'

UNIFORM FILTERING EFFICIENCY OVER THE ACTIVE LENGTH OF MEDIA



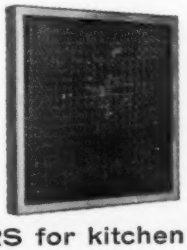
Continuous blanket... no motors... easy to install... simple to service

Engineered to assure high dust holding capacity, AGITAIR Type DS Pull-Down filters provide uniform filtering efficiency over the active length of the media with a savings in installation and maintenance costs. Available in a variety of sizes and capacities to meet your air filtration requirements.

Write for Technical Catalog DS-100

ALSO . . . AGITAIR PANEL FILTERS

HIGH VELOCITY
TYPE "FM"
Permanent, cleanable all metal construction. Large dust holding capacity and low resistance. Recommended velocity 533 fpm. Made in 1", 2", 4" thickness. Catalog available.



LOW VELOCITY
TYPE "AP"
Permanent, cleanable all metal construction. Effective filtration – low resistance. Recommended velocity 350 fpm. Made in 1", 2", 4" thickness. Catalog available.

and GREASE FILTERS for kitchen canopies

AIR DEVICES INC. • 185 MADISON AVE. • NEW YORK 16, N. Y.

BETTER PRODUCTS FOR— AIR DISTRIBUTION • AIR CLEANING • AIR EXHAUST

Engineering fundamentals of

Air Sanitation With Ultraviolet Light

Part 1

Fig. 1: *Ultraviolet lamps in indirect fixtures help protect children in the little red schoolhouse, Darien, Conn., from cross contamination.*

At last, a practical engineering guide on application of ultraviolet light for air sanitation in schoolrooms, bakeries, pharmaceutical plants, meat packing, wherever air should be sterile. Factual data on installation in air conditioning systems, air flow, location, lamp selection, will be included.

IN 1903 TWO ENGLISH RESEARCHERS, Barnard and Morgan, recorded that ultraviolet could destroy bacteria. Then, in 1930, F. L. Gates, in the *Journal of General Physiology,* showed that the most effective ultraviolet radiation to destroy micro-organisms was in the region of 2200 and 3000 Angstrom Units with a maximum effect at 2650 A. This destruction spectrum for bacteria was later verified by investigators both here and abroad.

About the same time that bacteria were shown to be sensitive to ultraviolet radiation, the lamp industry was actively developing new lamps which would utilize a mercury arc discharge. The mercury arc, characteristically, is rich in ultraviolet radiation. However, the early lamps had a very short operating life and a low efficiency in the production of bactericidal radiation. In addition, the lamps produced large amounts of ozone and were expensive to operate.

For a number of years bactericidal radiation remained a laboratory curiosity. It was not until 1936 that real interest was shown in the application of ultraviolet radiation to destroy bacteria, viruses and molds. At that time Westinghouse Electric Corporation announced the development of the STERI-LAMP® tube. About 90 percent of the emitted U.V. energy from the tube is in a single line,– 2537, – which approaches the peak of the bactericidal action curve. Some of these early tubes had poor maintenance, however, with the introduction of special transmitting glasses, the ultraviolet output has been doubled while the life of the tube was quadrupled.

Today there are fourteen basic types of bactericidal ultraviolet lamps available on the market. They vary in size, ultraviolet output, maintenance, life and cost. Each lamp has been designed for definite applications. Some of the lamps also emit a minute amount of 1849 A radiation for the production of ozone. These special lamps are used in Tenderay® process rooms and other high humidity rooms to destroy mold and bacteria and in special applications to oxidize odors.

Bactericidal radiation has been found to be most useful in the disinfection of surfaces, sterilization of

by J. C. Hoffman, ***Commercial Engineering Dep't.,*** **and R. Nagy,** ***Ph.D., Research Dep't., Lamp Division, Westinghouse Electric Corp.***

®—*U. S. Patent Office*

and, to some extent, sterilization of water. Irradiation of blood or vaccines to destroy viruses may also be accomplished through the use of special apparatus which will produce very thin layers of the material. Water is more transparent to 2537 A radiation. About 90 percent of the radiation will be absorbed in 15 centimeters of water. Practical water units to sterilize or make large quantities of potable water are made by a number of manufacturers.

The most extensive use of bactericidal radiation is in the disinfection of air. The air in a room can be disinfected by direct irradiation, by irradiation of only the upper air (indirect method) or by circulating the air from a room or an entire building through ducts containing high intensity lamps. Each of the methods will be described under the various applications.

Before the application of ultraviolet radiation became very extensive many investigators were looking into such questions as: How are bacteria killed? Can they be revived? How much energy is necessary to inactivate them? The killing of bacteria is a more complex process than some investigators would have us believe.

As an example, one theory explained that the radiation hits a vital spot in the organisms causing its death. This is not the complete story. Actually, there is good evidence that there are changes in the permability of the cell wall; many of the vital

(Please turn to following page)

TABLE I—INCIDENT ENERGIES AT 2537 ANGSTROM UNITS NECESSARY FOR COMPLETE DESTRUCTION OF VARIOUS MICRO-ORGANISMS

ORGANISM	HABITAT	(MW-SEC/CM²)
Bacillus anthracis	Cattle	8700
S. enteritidis	Infection of intestines	7600
B. Megatherium sp. (veg.)	Water and soil	2500
B. Megatherium sp. (Spores)	Water and soil	5200
B. paratyphosus	Typhoid fever	6100
B. subtilis	"Hay" bacteria	11,000
B. subtilis spores	"Hay" bacteria spore	22,000
Corynebacterium diphtheriae	Diphtheria	6500
Eberthella typosa	Typhoid fever	4100
Escherichlia coli	Intestines	6600
Micrococcus candidus	Mouth-non-pathogenic	12,300
Micrococcus sphaeroides	Soil, manure	15,400
Neisseria catarrhalis	Mucous membrane	8500
Phytomonas tumefaciens	Plant tumors	8500
Proteus vulgaris	Sewage	6600
Pseudomonas aeruginosa	Wounds, sinus	10,500
Pseudomonas fluorescens	Water and soil	6600
S. typhimurium	Disease of birds and animals	15,200
Sarcina lutea	Water and soil	26,400
Seratia marcescens	Water and soil	6160
Dysentery bacilla	Dysentery	4200
Shigella paradysenteriae	Dysentery	3400
Spirillum rubrum	Water	6160
Staphylococcus albus	Infections, food poisoning	5720
Staphylococcus aureus	Boils and serious infections	6600
Streptococcus hemolyticus	Rheumatic Fever	5500
Streptococcus lactis	Milk	8800
Streptococcus viridans	Focal infections	3800
B. mesentericus	"Rope" flour products	14,000
Yeast		
Saccharomyces ellipsoideus	..	13,200
Saccharomyces sp.	..	17,600
Saccharomyces cerevisiae	..	13,200
Brewers' yeast	..	6600
Bakers' yeast	..	8800
Common yeast cake	..	13,200
Mold Spores		
Penicillium roqueforti (Green)	Cheese	26,400
Penicillium expansum (Olive)	Apples	22,000
Penicillium digitatum (Olive)	Citrus Fruits	88,000
Aspergillus glaucus (Bluish Green)	Grain	88,000
Aspergillus flavus (Yellowish Green)	Soil	99,000
Aspergillus niger (Black)	All Foods	330,000
Rhisopus nigricans (Black)	Bread	220,000
Mucor racemosus A (White gray)	Meat	35,200
Mucor racemosus B (White gray)	Meat	35,200
Oospora laetis (White)	Milk	11,000
Microsporons (White)	Barber's itch	50,000
Trichaphytons (White)	Ringworm	50,000

Fig. 2: *Germicidal lamps being replaced in the air duct of a pharmaceutical plant. This system is said to destroy more than 99 percent of the micro-organisms circulating through it.*

Fig. 3: *Ultraviolet lamps are arranged in a square pattern on the ceilings of operating rooms at Duke University, Durham, N.C. These lamps provide 20-24 microwatts of germicidal radiation over the operating site.*

(Continued from preceding page)

enzymes are affected as well as the nucleo-proteins that carry the hereditary characteristics. A sublethal dose of radiation will injure the organisms so that many hours are required for them to start multiplying again. Some of the more critically injured organisms that would normally die can be revived by a short exposure to longer radiation or by use of a different culture media. This phenomenon is generally referred to as photoreactivation; however, the process is a laboratory curiosity and is not of importance in actual applications.

The amount of energy necessary to destroy various organisms is of interest for many applications. As an example, much more ultraviolet energy is necessary to destroy molds, yeasts and non-pathogenic organisms than disease producing bacteria (Table 1). Thus more lamps would be used in an air duct of a pharmaceutical plant making penicillin than in an air duct of an apartment house where we would be interested only in destroying pathogenic or disease-causing organisms.

The effect of humidity on the vulnerability of bacteria to ultraviolet radiation has been a controversial subject for many years. Professor Wells of the University of Pennsylvania and others claimed that nearly ten times more energy is necessary to destroy bacteria at high relative humidity than at very low humidity. The small amount of moisture in the air does not absorb the ultraviolet radiation but rather increases the size of the individual particles containing the organisms.

Since the first mechanical bacteria samplers did not collect the small particles but were efficient in collecting the larger particles, the increased collecting efficiency was interpreted as decreased ultraviolet efficiency. The amount of energy to destroy an organism is the same whether it is suspended in water or in low humidity air. Organic matter around the organisms absorbs the radiation and protects the bacterium. This explains why it is necessary to use more energy for organisms which tend to cluster such as *Sarcina lutea* and *Micrococcus sphaercides*. The spores are more difficult to destroy than vegative forms, especially if the spores are pigmented, such as the mold spores.

Operating Rooms—Direct Irradiation

A number of years ago Dr. Meleney, working in the Presbyterian Hospital of New York, estimated that between 30,000 and 60,000 viable organisms fell upon the "sterile" field during the course of an hour's operation. Later in a survey of thirty-seven operating rooms in seventeen states, Dr. Deryl Hart of Duke University Medical Center, demonstrated the universal presence of pathogenic bacteria in operating rooms during occupancy. Dr. Hart believed that most of the infections of clean wounds were caused by staphylococci organisms falling into the wounds or on sterile supplies. He later showed that the number of organisms settling on a Petri plate during an operation varied from 21 to 188 with an average of 67.

Drs. Hart and Jones reported that the pathogenic bacteria exhaled by the operating personnel were the predominant cause of infections in "clean incisions." By sterilizing the air with direct ultraviolet radiation, it was possible to obtain less than one colony per Petri plate per hour of exposure in the operative field. In a series of papers from 1936 to 1948 involving many thousands of operations, Dr. Hart and his associates have shown that this reduction in the number of air-borne pathogenic organisms will have the following effects:

1. Reduction of post-operative infections by 85 percent.
2. Elimination of occasional death from infection.
3. Reduction of post-operative temperature.
4. Reduction in duration of post-operative temperature.
5. Improved wound healing.
6. Lessened systemic reaction.
7. Shortened convalescence.

These effects were most pronounced in patients

ject to extended surgery, like, thorocoplastics.

More recently, from October 1, 1956 to January 1959, when most hospitals had a post-operative of infection from staphylococcus aureus of about percent, the Duke University Hospital rate was percent. These figures were based on 7095 large rations.

To add a dramatic proof of the effectiveness of violet lamps, Dr. Hart reports an accident ch happened in one of the rooms. The voltage ulator supplying current to the lamps became de- ive and the lamps did not produce ultraviolet about a month. In this short time lapse there re four infections in 43 operations or an infec- n rate of 10 percent. This accident, however, also tated that all ultraviolet lamps must be monitored iodically for their ultraviolet output if maximum tection is to be obtained.

The intensity of direct bactericidal radiation ed in such operating rooms is 20 to 24 micro- tts/cm² as measured at the operating site. This tensity of radiation is obtained by mounting four Vestinghouse SB-30 ultraviolet fixtures on the ceil- g of the room. Each fixture is equipped with a ngle 782L-30 STERILAMP® tube. The lamps are a cold cathode design offering long life and ex- llent maintenance.

The intensity of radiation from the lamps can e varied by means of a voltage controller usually cated outside the operating room. Intensity adjust- ents are made to compensate for various room eights and for the slight depreciation of the ultra- olet output that occurs with time. In some instal- tions having very high ceilings, it may be necessary use additional fixtures to obtain the proper in- nsity and distribution of radiation.

One question which may be asked is what effect ould this energy have on living tissue? Dr. Hart nd his associates have shown that intensities of bout 20 microwatts/cm² have caused no demonstra- le harm to skin, peritoneum, meninges, or other issues exposed. Dr. Kraissl and his associate Dr. Fraser also demonstrated that organisms will be estroyed before injury to tissue. Dr. Odom ex- osed the brains of twelve dogs to an intensity of 6 microwatts/cm² for as long as 30 minutes with no pronounced effect on the tissue.

The unprotected skin and eyes exposed to high ntensity bactericidal radiation can result in an rythema conjunctivitis. However, the operating am wears a visor and glasses to protect the face nd eyes. The eyes of the patient are normally losed or covered by the anesthetist.

Operating Room—Indirect Irradiation

Another method of irradiating air in an operating oom is by indirect radiation. While not as effective r efficient as the direct method, indirect radiation liminates the need for protective clothing. Ultra-violet lamps are hung on the wall in specially designed fixtures which irradiate only the upper air of the room. The recommended average intensity of 2537 A radiation is 50 microwatts/cm² which can generally be obtained with four 30 watt germicidal lamps in louvered fixtures. The fixtures are hung 6½ to 7 ft. from the floor. The normal circulation of air in a room exposes the air-borne organisms to the high intensity radiation in the upper portion of the room.

The average reduction of air-borne organisms is about 50 to 70 percent. Published figures are not available on the reduction of the incidence of infection of clean wounds by this method. Based on previous data, however, it would be logical to assume that the reduction of infection would be proportional to the reduction of air-borne organisms at the wound.

Air Ducts

Air entering an operating room or ward through ducts can be disinfected with high intensity ultraviolet emitting sources. Large volumes of air can be disinfected by a small number of lamps requiring simple installation. The amount of bactericidal energy required and the various factors affecting the efficiency of the method have been discussed in various publications. The most efficient method of utilizing the radiation is to place the lamps in the middle of the longest straight section of the duct and perpendicular to the air flow. Based on actual tests in a large duct, curves were obtained, (Fig. 4), simplifying the method of calculating the number of lamps necessary for various sizes of installations. The following formula is applicable to all commercial and industrial forced air systems.

$$\text{Number of lamps required} = \frac{\text{cfm}}{\text{V.D.W.} \times \text{Corrected lamp output}}$$

Where: cfm = Cubic feet per minute of the system

V.D.W. = Volume (cfm) of air disinfected to 90 percent by one watt of 2537 A radiation.

Corrected lamp output obtained from Fig. 5.

Thus, if we have a small duct 30 x 30 x 36 in. carrying 2700 cfm, only four G36T6 Sterilamp tubes, each requiring 39 watts, would be necessary to obtain 90 percent disinfection of the air. For large, odd size ducts where 2 or 3 banks of lamps may be required Fig. 6 offers necessary correction factors. For all practical purposes it is not necessary to destroy more than 90 percent of the organisms in air ducts of public offices. It has been shown that the remaining 10 percent of the organisms are injured and do not multiply as rapidly as non-exposed or-

(Please turn to page 35)

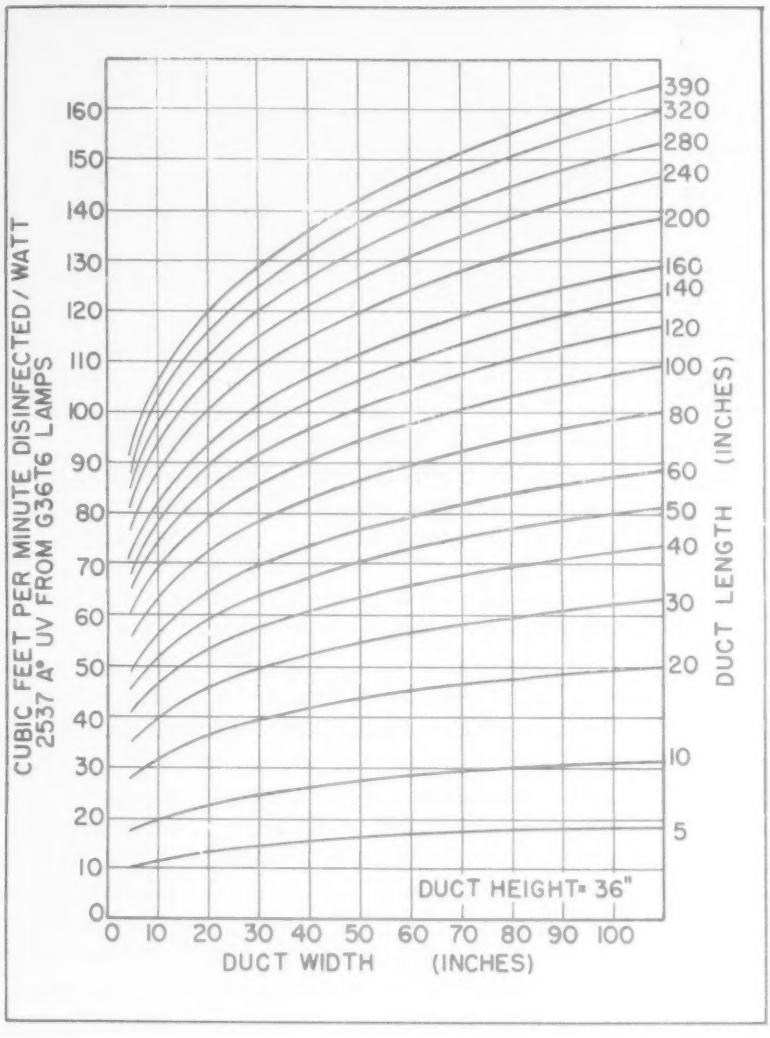


Fig. 4: *Curves in drawing shown here were obtained from actual tests in ducts, will simplify method of calculating number of lamps necessary for various sizes of installations. Use formula in text.*

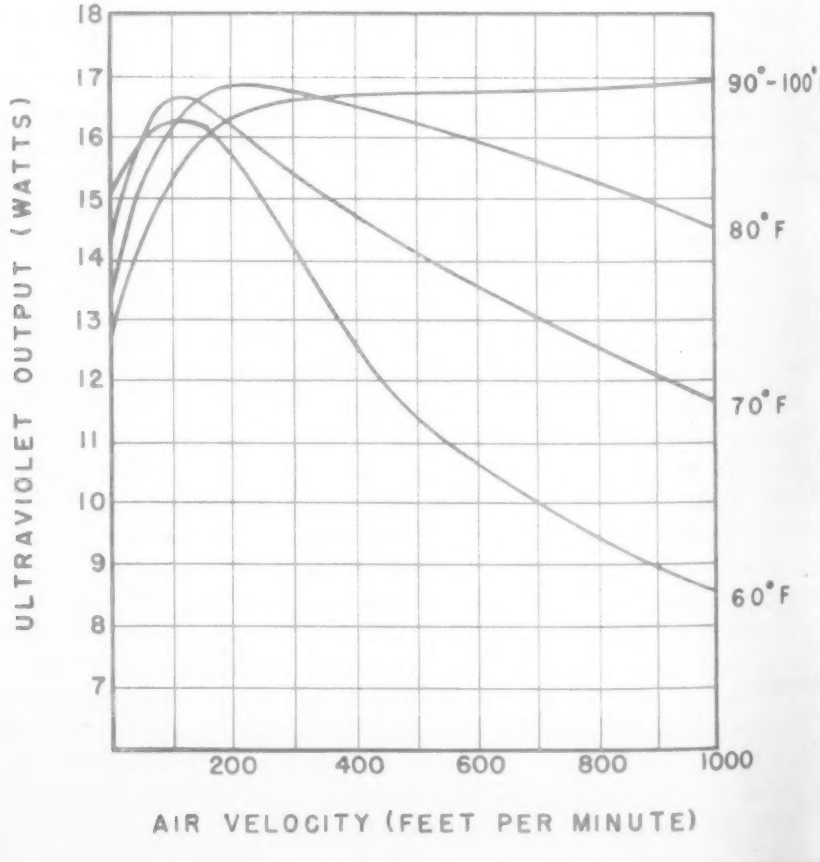


Fig. 5: *This chart gives correction factors for lamp output as affected by temperature and air flow, for G36T6 slimline Sterilamp, at 420 ma.*

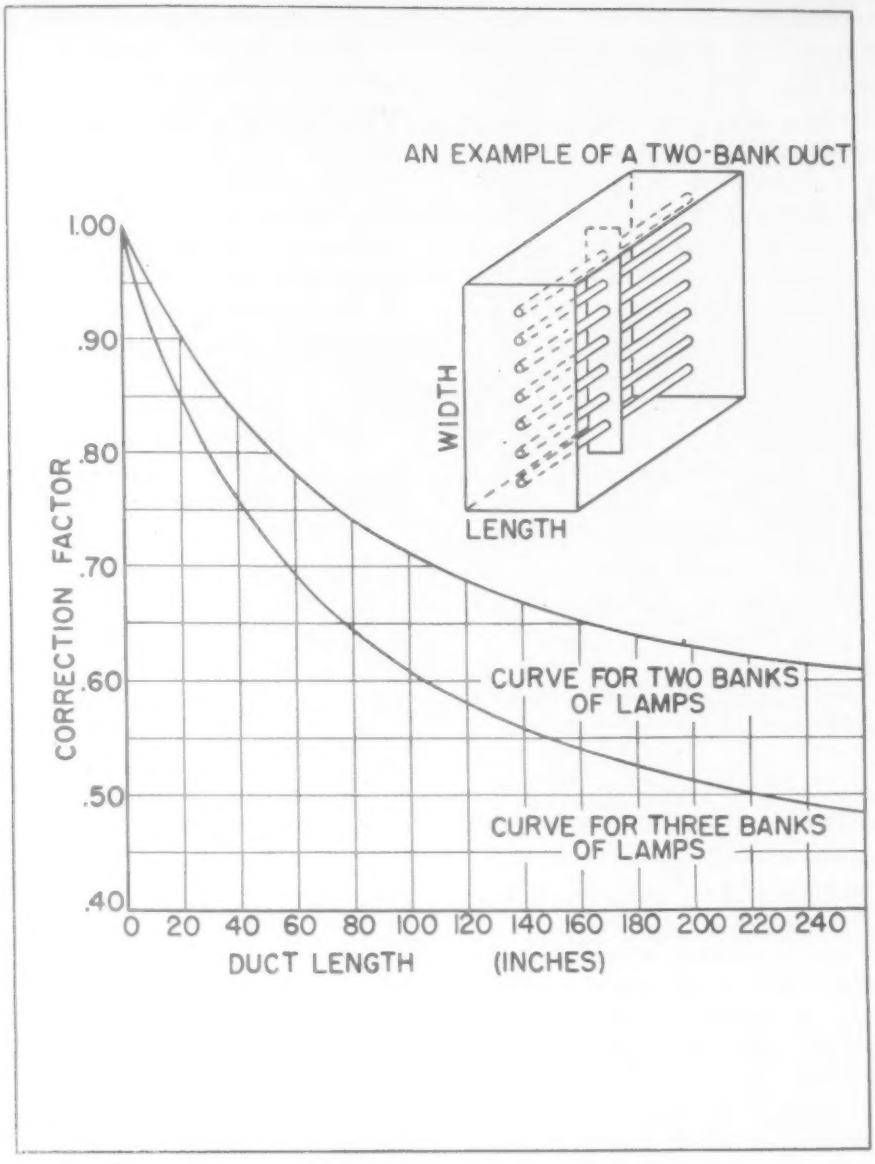


Fig. 6: Chart shows correction factors for odd size ducts, where two or three banks of lamps may be required.

(Continued from page 33)

ganisms. However, in ducts supplying air to an operating room or coming from contagious wards the object would be to destroy all of the organisms.

Tests have shown that to obtain smaller survival values, it will be necessary to multiply the number of lamps necessary for 90 percent disinfection by the following factors:

95 percent kill . . . 1.5
98 percent kill . . . 2.5
99 percent kill . . . 3.3

Thus sterile air can be piped into an operating room using ultraviolet radiation. However, if we assume ten changes of air per hour, some of the organisms would be in the air about ten minutes before being removed from the room. During this time they could fall on a wound. If direct radiation is used the organisms would be destroyed or injured so they would not multiply so rapidly. Also all of the organisms that have settled on the floor and may later reinfect the air are destroyed by direct radiation.

While a greater attempt is generally made to supply sterile air to operating rooms, other sections of a hospital must not be forgotten. Drs. Robertson and Doyle of the University of Toronto have shown that cubicles in an infant ward had an average of 61 organisms per cubic foot. A large ward had an average of 360 organisms per cubic foot, while tests in an outpatient department had an average of 407 organisms per cubic foot, with some days as high as 706 per cubic foot.

A series of tests by Dr. Robertson showed that barriers of ultraviolet radiation between cubicles were effective in preventing the spread of artificially introduced bacteria from cubicle to cubicle. Dr. Robertson also showed in a two and one-half hour study on the use of "curtains" of ultraviolet radiation and upper air irradiation in a children's hospital, that there was a reduction in the number of respira-

(Please turn to following page)

(Continued from preceding page)

tory infections in infants. Drs. Higgons and Hyde of St. Lukes Hospital, New York City, in a 3 year study, demonstrated that ultraviolet radiation in a children's hospital reduced the incidence of respiratory infection by as much as 33 percent. Dr. Friederiszick of Germany also showed that indirect ultraviolet radiation in a children's hospital reduced to a considerable degree infections of the upper respiratory tract and their complications.

Ultraviolet lamps have been employed in tuberculosis hospitals. Dr. MacVandiviers demonstrated that indirect ultraviolet radiation in a room can destroy over 70 percent of air-borne organisms, some of which were *M.* tuberculosis. More recently Dr. Riley of Johns Hopkins University and his associates have used "curtains" of radiation to prevent the spread of air-borne tubercle bacilli to other portions of the hospital. Dr. R. L. McLean of the Veterans Administration Hospital, Livermore, California, reported a substantial reduction in the number of Asian flu cases in rooms equipped with indirect ultraviolet fixtures compared with unirradiated control rooms. High intensity radiation has also been used in some hospital autopsy rooms to destroy organisms on the tables, floor and in the air.

Another interesting application of ultraviolet lamps is for the sanitization of ward rooms or nursery cubicles. Dr. Hart found a dramatic reduction in the number of organisms generally found on furniture, floor and walls of a room by the use of a mobile unit, equipped with 6 – G36T6L STERILAMP® tubes. After a patient has been discharged the unit is wheeled into the room and kept for a period of time in about four different locations. In another method used in a nursery, the STERILAMP® tubes are permanently mounted on the ceiling of the cubicle. These lamps are turned on immediately after the discharge of the infants so that the air, floor and furniture are disinfected before the next infant is admitted. Indirect ultraviolet radiation is used at all times.

Pharmaceutical Laboratories

In the preparation of biological materials the room atmosphere of a pharmaceutical plant must be as sterile as that found in the best conducted operating room. To obtain this protection, ultraviolet lamps are being used today in every pharmaceutical laboratory in one or more different ways.

The supplying of sterile air to a particular location may be accomplished in several ways in the pharmaceutical plant. One method is the use of germicidal tubes in air ducts as described under the previous section. Where greater sterility is desired, direct radiation such as prescribed for the operating rooms is used. The same type of personal protection must also be worn. Where sterility requirements are not so stringent, as in hallways to sterile rooms, indirect fixtures may be employed.

In the filling of ampuls, biological material is protected by placing the ampuls in a hood equipped with ultraviolet lamps. The intensity of radiation in the hood can be 100-200 microwatts/cm². This will require protection for the operator's arms, face and eyes because many surfaces will reflect some 2537 Å radiation. Even with this intensity of radiation about 30 to 60 seconds will be required to destroy many of the organisms that could be carried into the hood by air currents. The organisms outside of the hood in the room, can be destroyed by direct radiation similar to the procedure used in the operating room.

Another method used in ampul filling is to produce a positive pressure of sterile air in the hood. Such a hood has been designed by Mr. John Yunker of Milwaukee, Wisconsin. Air is blown into a chamber equipped with high intensity ultraviolet lamps and then the air is diffused into the hood. Although tests have shown that sterile air can be obtained by such a method, direct ultraviolet radiation in the room would reduce the room contamination, thus further insuring the sterility of the air in the hood.

Finally, ultraviolet radiation has been used directly for the preparation of many biological materials. As an example, a number of types of apparatus have been developed for the irradiation of blood for the purpose of inactivating the virus responsible for jaundice. The whole blood is inactivated as a thin film on a rotating cylinder. Other modifications have been made for the preparation of polio and other types of vaccines. These materials have a very high coefficient of absorption, so that film thickness becomes very critical.

Lamp Maintenance

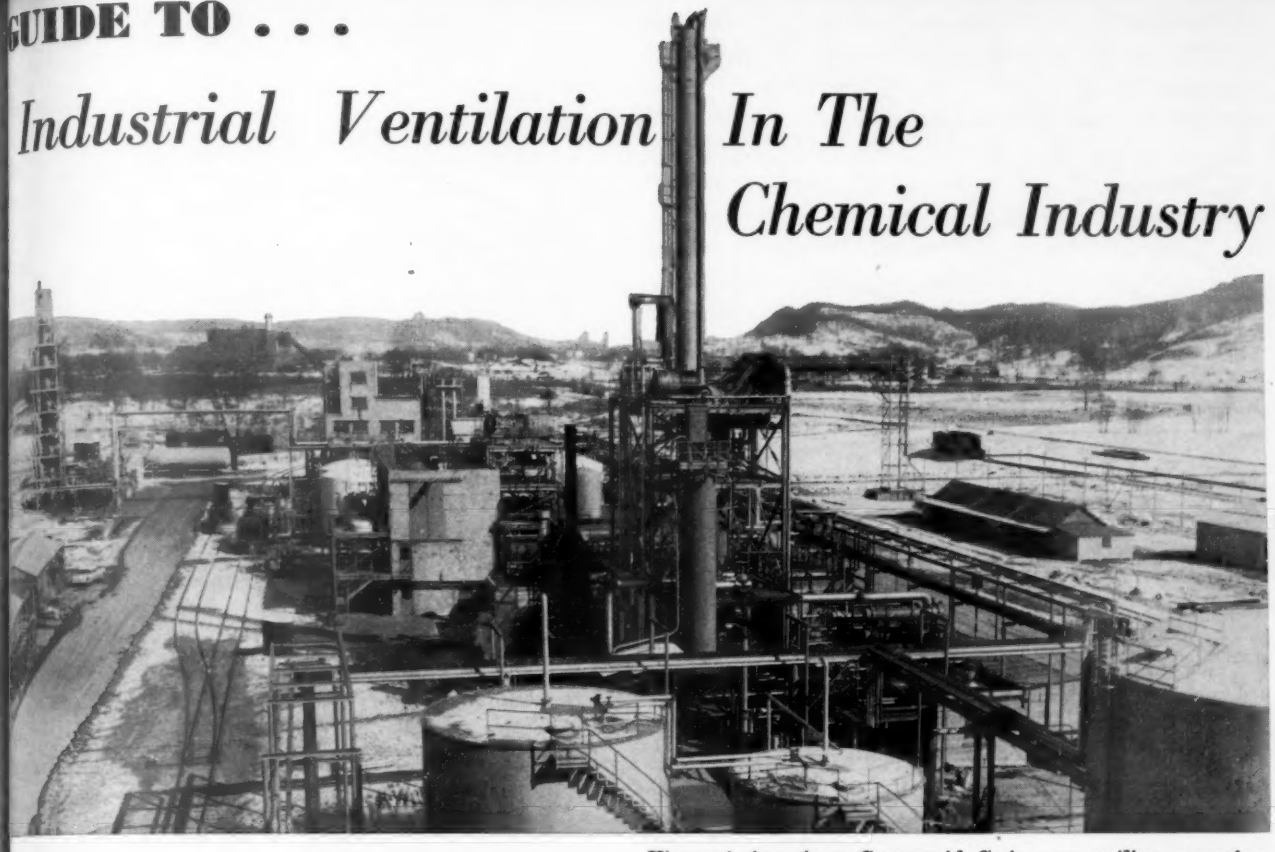
Ultraviolet lamps – just like all other types of lamps – must be cleaned and periodically replaced to insure maximum efficiency of the installation. The lamps should be turned "off" and washed with alcohol once a month to remove accumulated grease and dirt.

If the ultraviolet output as read on the Westinghouse SM600 meter is less than 70 percent of the published values for that lamp, the lamp should be replaced. Specular aluminum is generally used in ultraviolet fixtures because of its high reflectivity to this radiation. The fixtures should also be cleaned. It is recommended that ultraviolet lamps in air ducts be preceded by dust filters. The filters should be periodically replaced or cleaned to minimize the amount of dust settling onto the lamps. Proper installation of ultraviolet lamps coupled with simple maintenance can assure sterile air for the pharmaceutical laboratories and thus assure a sterile product.

Next month, part II will discuss applications of ultraviolet lamps to schoolrooms, barracks, commercial and residential structures, food industry and generation of negative ions.

GUIDE TO . . .

Industrial Ventilation In The Chemical Industry



View of American Cyanamid Co.'s new aniline manufacturing facilities at Willow Island, W. Va. Plants such as these require careful design of ventilating systems to maintain employee health.

By William V. Andresen
Chief Industrial Hygienist
American Cyanamid Co.

Problems of chemical filtration are many and complex. Here's a detailed discussion on mechanical exhaust ventilation for control of gases, mists and vapors liberated during filtration. Points highlighted include employee exposure, hood enclosure design, and filter types.

FILTRATION AS USED in the chemical industry may be defined as the separation of solids from a liquid by passing both the solid and liquid mixture through a porous medium. The purpose of the filtration may be to deliquify and wash a solid product, or to clarify a liquid product by the removal of small amounts of solid material.

Various solvents, acids, alkalis and other toxic or irritating liquids may be involved in chemical filtrations as liquids to be filtered or as a washing medium. The filtered product itself may be toxic.

There are three general classifications of filters used in the chemical industry: (1) Gravity Filters, (2) Vacuum Filters, and (3) Pressure Filters.

This article discusses employee exposure problems in some of the batch- and continuous-type vacuum filters used in the chemical industry and the designs of hood enclosures and mechanical exhaust ventilation used to control gases, mists and vapors liberated during filtrations.

Batch Vacuum Filters

The Nutsche filter, encountered in various sizes and shapes, is widely used in the chemical industry for batch vacuum filtration. The Nutsche filter consists of a tank into which a porous filter medium is installed and supported, so that filtrate will drain through the filter medium and collect in the bottom of the tank. Vacuum is applied beneath the filter medium.

(Please turn to following page)

***WILLIAM ANDRESEN** is chief industrial hygienist for the American Cyanamid Co. A graduate engineer, he is vice chairman of the Bergen County, New Jersey air pollution control committee. He is also a delegate from the National Safety Council to the American Standards Association committee Z-9 on industrial ventilation. He is a member of the American Industrial Hygiene Association.*

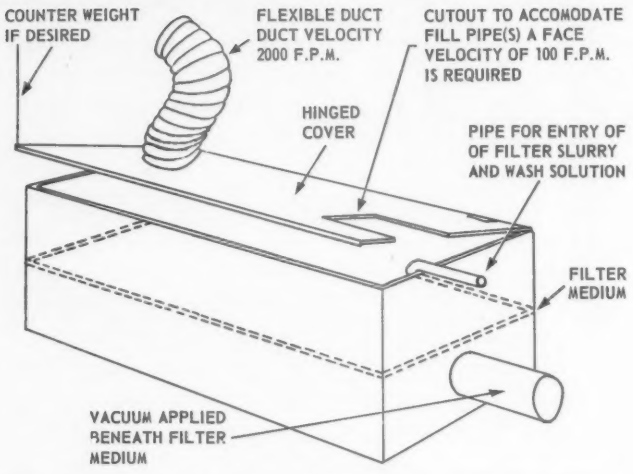

COUNTER WEIGHT IF DESIRED
FLEXIBLE DUCT DUCT VELOCITY 2000 F.P.M.
CUTOUT TO ACCOMODATE FILL PIPE(S) A FACE VELOCITY OF 100 F.P.M. IS REQUIRED
HINGED COVER
PIPE FOR ENTRY OF OF FILTER SLURRY AND WASH SOLUTION
FILTER MEDIUM
VACUUM APPLIED BENEATH FILTER MEDIUM

Fig. 1: *For simple operations where exposure occurs only during filtration, an operation of this type can provide satisfactory control. Small openings permit observation as well as performance.*

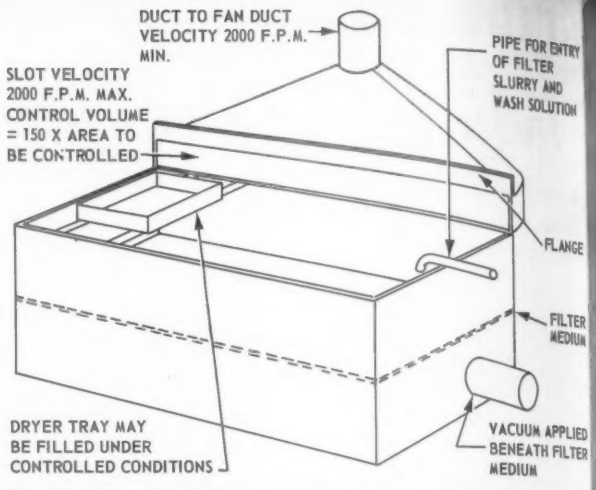

DUCT TO FAN DUCT VELOCITY 2000 F.P.M. MIN.
PIPE FOR ENTRY OF FILTER SLURRY AND WASH SOLUTION
SLOT VELOCITY 2000 F.P.M. MAX.
CONTROL VOLUME = 150 X AREA TO BE CONTROLLED
FLANGE
FILTER MEDIUM
DRYER TRAY MAY BE FILLED UNDER CONTROLLED CONDITIONS
VACUUM APPLIED BENEATH FILTER MEDIUM

Fig. 2: *For operations requiring observation during both filtration and washing, a slot-hood type enclosure may be used.*

Chemical Ventilation . . .

(Continued from preceding page)

Employees may be exposed to toxic or irritating gases, vapors and mists during filtration washing, product removal or during any combination of these operations.

If exposure is present only during filtration and the filtered solid is washed with water after initial filtration and no toxic or irritating material remains, satisfactory control may be realized as shown in Fig. 1. The filter is provided with a cover with openings as small as possible for observation and performance of necessary operations. A control velocity of 100 fpm, across the openings, usually provides satisfactory control. Cover is opened when the product is removed from the filter.

In many filtrations, it is desirable to keep the filter open to observe filtration and washing operations to insure that the cake does not crack. Filtrate and wash solutions may be volatile and liberate toxic or irritating vapors to the work atmosphere. Slot hoods or booth type enclosures can be used to provide the required control, as shown in Figs. 2 and 3.

In the booth-type enclosure, it is advantageous to enclose the filter as much as possible, while still allowing easy removal of the filtered product. A control velocity of 100 fpm, across the open face of the hood, provides satisfactory control for the booth-type enclosure.

Slot hood air volume requirement is determined by multiplying the area to be controlled by 150.

The final filtered product may also be toxic or may contain residual materials which are toxic or irritating by inhalation. Transfer of the filtered product into tray or truck dryer pans may be accomplished under controlled conditions as shown in Fig. 3. However, it may be necessary to provide exhaust ventilation control for the dryer truck into which the pans are loaded. Design of ventilation for control of this operation is to be described in a future article.

The transfer of filtered material into drums or tote boxes will probably require additional ventilation. Fig. 4 shows the utilization of portable slot hood ventilation for control of vapors or gas from this transfer operation. An air volume equivalent to 150 times the area to be controlled usually provides the desired control. Booth enclosure may also be used to control vapor liberations, but requires a large permanently located hood installation.

The Nutsche filter is also used for gravity and pressure filtration. The hood and ventilation described may be used for gravity filtration applications. A different ventilation design is required for pressure application of the Nutsche filter. (This will be described in a future article dealing with closed pressure type filters.)

(Please turn to page 41)

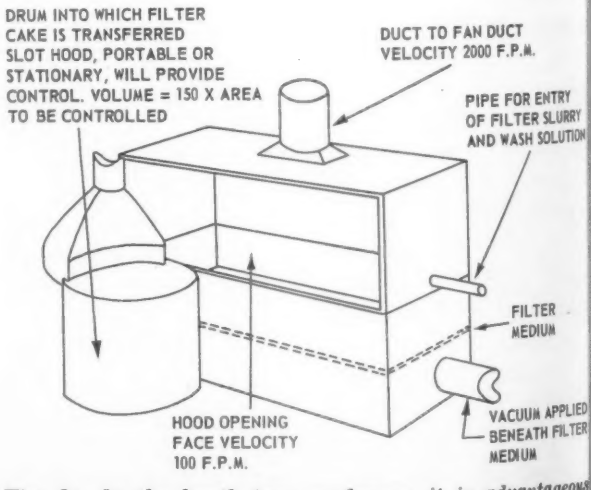

DRUM INTO WHICH FILTER CAKE IS TRANSFERRED SLOT HOOD, PORTABLE OR STATIONARY, WILL PROVIDE CONTROL. VOLUME = 150 X AREA TO BE CONTROLLED
DUCT TO FAN DUCT VELOCITY 2000 F.P.M.
PIPE FOR ENTRY OF FILTER SLURRY AND WASH SOLUTION
FILTER MEDIUM
HOOD OPENING FACE VELOCITY 100 F.P.M.
VACUUM APPLIED BENEATH FILTER MEDIUM

Fig. 3: *In the booth type enclosure, it is advantageous to enclose the filter as much as possible, while still allowing easy removal of filtered product.*

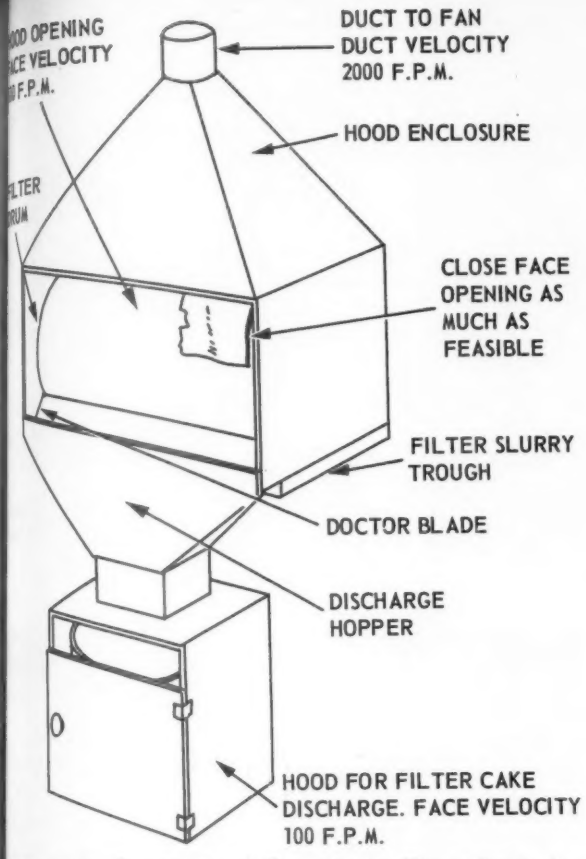


Fig. 4: *If in the course of the process, filter cake is discharged into tote boxes or drums, a ventilation set-up similar to that above may be required.*

Chemical Ventilation . . .

(Continued from page 38)

Another type of batch filter utilized in the chemical industry is the Moore-type filter. This filter consists of a group of filter leaves on a portable assembly. Vacuum is applied to the leaves through a flexible hose. The filter assembly is lowered into a tank containing the product to be filtered and vacuum is applied until a filter cake of desirable thickness has been formed on the filter leaves.

The assembly is then lifted from the tank and washed by lowering into a second tank containing a wash solution. The filter cake is removed by blowing air through the flexible connection and filter leaves. It can be seen that a filtration of this type requires considerable space. The operation does not lend itself easily to filtrations where toxic or irritating substances are involved. If control is necessary, the most practical method of enclosure of the whole operation as much as possible. Continuous vacuum filtration has replaced the Moore-type in many applications.

Continuous Vacuum Filters

The continuous vacuum filter, most commonly used, consists of a hollow drum, covered with a filter medium, which rotates slowly through a pan containing material to be filtered. Vacuum is applied to continually filter product from the pan. The filter cake may be washed by sprays, the wash solution being drawn through the cake by the vacuum; filter cake is dewatered by vacuum and is removed by doctor blade, strings or air pressure.

The solution, or slurry to be filtered, and the wash solution used may be toxic or irritating. Satisfactory control of vapor mist or gas liberated during filtration may be realized by booth-type hood enclosure of the filter. Rotary vacuum filters with vaportight enclosures may be purchased. If closed operation can be performed, control can be realized by venting the enclosure to the outside atmosphere.

However, operation of the filter often requires frequent adjustment of wash sprays, doctor blades, etc., and filter must be operated partially open. Fig. 4 shows a hooded rotary vacuum filter. The opening for process adjustment should be kept as small as possible. A face velocity of 100 fpm across the open hood face usually provides the required control.

It is possible, where the filtration and washing operations are hot and the hood opening small, to utilize natural draft ventilation to provide the air volume necessary for control. Either centrifugal or axial flow fan are utilized where mechanical air moving equipment is required.

If there is a possibility of the filter cake dusting and the dust being exhausted, the axial flow fan is preferable, as it may be installed in a straight vertical duct. The elbows and horizontal duct runs, required with a centrifugal fan, provide greater possibility of duct blockage when dust and moisture are exhausted simultaneously.

If the filtration is being performed to filter and wash a solid product, the filter cake is usually discharged directly to, or through, extruding equipment to a dryer. Usually, this can be operated as a closed process requiring no additional ventilation.

If filtration is for clarification purposes, the filter

(Please turn to page 59)

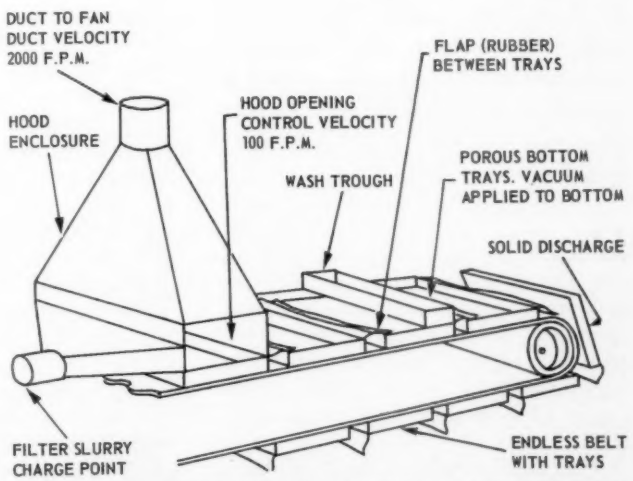


Fig. 5: *A general design of a continuous horizontal, endless, belt vacuum filter and hood enclosure for contaminant control during filtration.*

One of the toughest air pollution control problems . . .

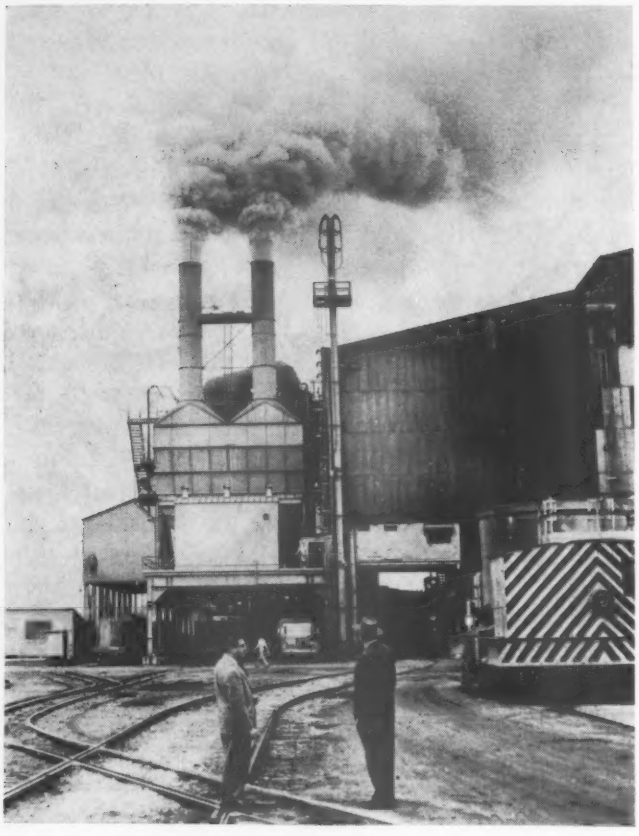


Fig. 1: *Electrostatic precipitator in "off" condition at steel plant.*

How to Control Emissions From Electric Steel Melting Furnaces

PART II

by V. C. Doerschuk
Secretary,
Joint Smoke Control Research Committee
Allegheny County, Pa.

Source and composition of emissions, dust loadings, collection efficiency, dust disposal, cfm requirements, types of cleaning equipment and detailed cost data are given in this installment.

Last month's article discussed the electric furnace emission control problem in general, described various methods of collecting dusts and fumes from the collected emissions. Use of fans, natural ventilation, collecting hoods, roof-tap systems and duct systems were outlined.

DUSTS, FUMES AND SMOKE in electric furnace emissions originate from the mechanical and chemical reactions of hot gases and arcs on the charged materials, which include scrap and other forms of iron and steel, flux, ores, alloys, etc.

The emissions are largely particulate, consisting of oxides with a small amount of metallics. There is some "smoke" from combustibles in the charge. There is some CO_2 from the carbon electrodes and certain fluxes. The balance is atmospheric gases.

The amount of emissions produced depend upon the composition of the charge, oxidized and oily materials causing more. A high melting rate and a high furnace temperature produce more. More is produced during the melt down. One report says 75 percent of the dust is produced in the first half of the heat. Careless additions of fine flux materials cause more dust. The largest rate of emission occurs during the oxygen lancing and then about 15 percent more cfm are needed.

The amount also depends upon the suction placed on the furnace and the emission exits. It also depends on the efficacy of construction, size and placement of the various segments of the collecting apparatus. The amount collected with a hood not completely closing an exit such as a door will depend upon the mesh of the dust, the coarser portions possibly not being entrained. A hood placed some distance above the roof will not collect all escaping dust without a larger suction being placed upon it. Similar principles also apply to the roof-tap system.

To collect the emissions it is necessary to close, as tightly as possible, all furnace openings through which these can escape, except where the collecting is done. This means plugging the tap hole except when in use, door designs which allow tight closing, and attention by operators to keep all openings closed, except those where emissions are collected.

Air entering the furnace may cool the slag and the melt, requiring increased power. It is better to introduce cooling air to as large an extent as possible after the

Precipitator in Fig. 1 in "on" con- ... ome steel plant. Figs. 1 and 2 ... Western Precipitation Div., Joy

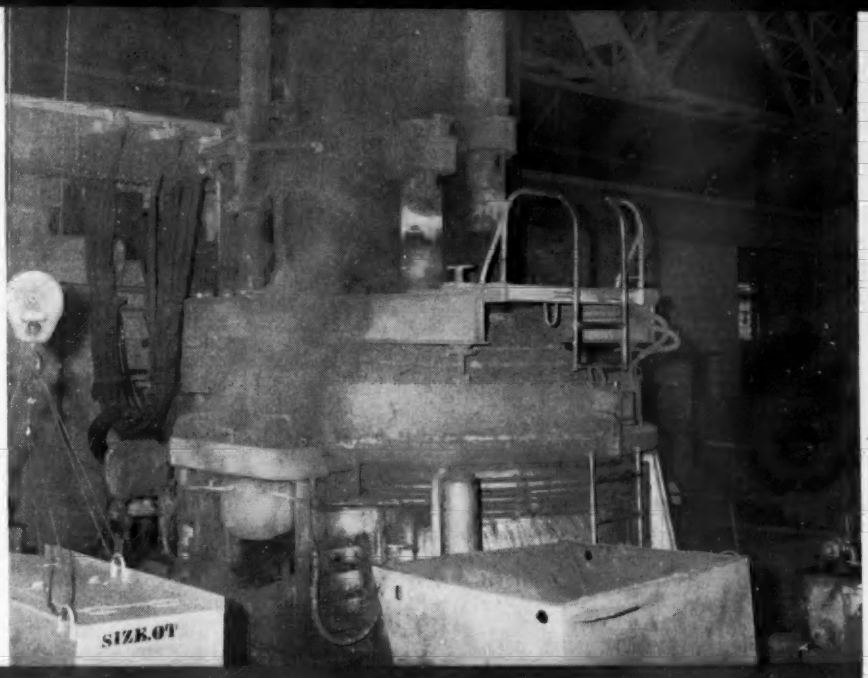


Fig. 3: Electric melting furnace before application of furnace hood. General ventilation discharges fumes, dusts to atmosphere.

emissions have been collected, rather than before. However, enough air must be used at the emission exits, in order to entrain them.

The dust caught by the cleaner depends upon its efficiency, and is usually expressed in pounds per ton of furnace product.

Reports of the quantity are variable and are reported as follows:

Lbs.	Cases
2	1
3	2
4	1
6	3
7	1
9	1
10	2
11	1
14	1
18	1
up to 30	2
37.8	1

The reasons cited account for most of these variations, and there are also differences, for example, between melting stainless, other steels, or cast iron.

The amount of dust in the gas stream may be expressed in grains per scfm, or in pounds per 1000 pounds of gas (as air). The latter is 1.87 times the former.

Dust loading depends upon the stage of the heat when sampled, and whether samples are taken before or after the exhausted stream has been diluted. If samples are taken near the furnace, the roof-tap will show a higher loading than the hood since in the latter more cooling air has already been entrained. Few dust load figures are available.

Following are averages taken at the cleaner. With hoods: normal 0.4 to 0.6 gr/scf; when lancing 1.0 to 2.3. With roof tap: One case 0.75 to 0.87; one case after the slip joint 1.98 during initial melt, 3.25 during lancing, 2.30 when shaping slag.

Dust loading can be calculated from certain assumptions, e.g., 15 foot furnace, tons per heat 37, hours per heat 5.5, cfm at cleaner 38,000, pounds dust per ton of product 10. This gives grains per cu. ft. 0.206, pounds dust per 1000 pounds gas 0.385. These are averages and do not show loading during various stages of the heat.

The mesh of collected dust from 6 sources is shown in microns:

	Percent
Larger than 44	**7 to 16**
10 to 44	**7 to 71**
Less than 10	**18 to 80**

Others say: 95 percent is less than 0.5 with none over 2. 70 percent is in the 0.5 range. 92 percent is in the 0-44 range.

The dust composition taken from 6 sources:

	Percent
Fe_2O_3	**35 - 42**
CaO	**6 - 15**
Al_2O_3	**3 - 13**
MnO	**4 - 12**
SiO_2	**2 - 10**
FeO	**4 - 8**
MgO	**2 - 8**
C	**2 - 8**

Misc.: Zn, Cr, Cu, etc.

Both of these tables show wide differences between various operations, as may be expected.

Other comments on dust: The agglomerating tendency is pronounced. The dust is tricky, it cakes and is difficult to shake loose from bags. The solid emissions have a strong tendency to adhere to natural and synthetic fabrics, they possess a high angle of repose, they are difficult to wet, they have a high electrical resistivity. Specific gravity is given once at 3.93.

Dust is mostly wasted to a dump. In one operation a mixer was installed to mix the dust with water, then the slurry was to be wasted, but since it would not wet easily, this operation was expensive and was abandoned. Some report that the dust is placed on a dump, then wetted to lay it.

In one operation using a wet washer and a wet disintegrator, the waste water is ponded, treated to settle the suspensions, the the slurry is wasted. One operator reports that the dust is briquetted, then sold as blast furnace charge. One operator placed the dust in paper bags into the furnace with the charge placed on top. This was later discontinued.

(Please turn to following page)

Electric Furnace Air Cleaning

(Continued from preceding page)

For the same size of furnace there are wide variations in scfm depending upon variations in furnace operations, types of control systems, methods of cooling the collected gas, to what temperature it is cooled, ordinance requirements, whether oxygen is used, etc.

Cfm data was used from 20 companies using hood collecting on 43 furnaces, and from 6 using roof-tap collecting on 16 furnaces. The cfm was plotted by furnace size in the two cases, with the points rather scattered, especially with the smaller furnaces.

Approximate medians are about as below with the use of hoods and air cooling.

Fce. Dia.	Tons Cap.	1000 cfm	cfm Area	cfm Ton
6	2.5	8	280	3200
8	4.5	15	300	3300
10	9	23	290	2600
12	16	30	270	1900
14	26	36	230	1400
16	45	40	200	900
18	67	43	170	650
20	91	45	140	500

Below is data for the roof-tap system, using air and/or water cooling.

Fce. Dia.	Tons Cap.	1000 cfm	cfm Area	cfm Ton
9	4.5	4.2	85	930
10	11	19	240	1730
17	50	28	125	560
19	80	8.2	30	105
20	75	38.5	125	510
20	115	45	140	390
24½	187	14	30	75

Cfm increases with furnace diameter. For smaller furnaces cfm per sq. ft. of area and per ton capacity are somewhat the same, but for larger furnaces these decrease as size increases.

In a 10 ft. furnace there is about 6.3 sq. ft. of hearth area per ton capacity, in a 20 ft. furnace this is about 2.7. Thus, in the smaller furnace there is more melt surface exposed per ton than in a larger one. This may partly explain the greater cfm needed per area and per ton for the smaller furnace, if we assume the larger area per ton capacity gives rise to more emissions because of more oxidation, more turbulence in the metal caused by the arcs and more flux area exposed.

Also, small furnaces have more area of air leakage and of air intake openings than large furnaces, compared to roof area and capacity. This would require greater cfm per area and ton in order to remove emissions.

With a hood system using air cooling, the following is an example of the theoretical cfm values.

Assume a 14 ft. furnace 36,000 cfm at 200°F at the fan. Cooling air 75°. Air leaking into and gas generated in the furnace, leaving it and entering the hood at 2000°. Constant specific heat and humidity. One calculates 2340 cfm leaving the furnace and 33,660 cfm cooling air entering canopies, hood, slip joint and elsewhere. This does not consider cooling by radiation from ducts, etc.

With roof-tap collecting, similar relations hold as with hood collecting. However, the cfm is in general lower, due, no doubt, to the use of water cooling.

The Foundry Air Pollution Control Manual of American Foundryman's Society gives a comparison between direct water and air cooling: to cool 30,000 cfm at 600°F to 275°. Ambient air 80°. Spray water 70°. Tempering air required 35,423 cfm at 275°. Air to be cleaned 56,217 cfm at 275°. Water needed for the same cooling 78.86 lbs./min. or about 9.45 gal/min. Air to be cleaned with water cooling 23,118 cfm at 275°.

The above data measured at 60°F follows:

AIR COOLING

Original	**14700 scfm**
Cooling air	**25100**
To Cleaner	**39800**

Water Cooling

Original	**14700**
To Cleaner	**16350**
Added by water vapor	**1650**

In the above it was assumed that the air to be cooled and the ambient air each contained .01 lb. water vapor per lb. dry air.

Cleaning Equipment

Most installations use bag houses with Orlon or Dacron cloth. These are said to withstand 275°F with long life, and 350° with short life. Cotton should not exceed 180° and wool 215°. Woven glass fibre withstands 500° or more, it is silicone treated for lubrication, and this treatment also causes less sticking of dust on the bags.

Some report that no more than 2 cfm per sq. ft. of cloth should be used. One operator reports a 3 year bag life with Orlon with a ratio of 2.4 to 2.9. One operator using Orlon reports an 18 month life. These through-put ratios are for bags which are cleaned by shaking, and not for the reverse jet method of bag cleaning which allows a higher ratio. Bag efficiencies have been reported over 99 percent.

One operator uses a Cottrell, conditions the dust with moisture and holds the temperature at about 127° for the best performance. Ordinarily the Cottrell has a lower efficiency than bags.

Some operators have used wet washers, home made or purchased, but most have changed to bags. The consensus is that wet washers do not remove the extreme fines and thus allow a color plume discharge, corrosion takes place, maintenance is high, and disposal of the wet slurry is difficult and expensive.

One operator uses a vertical water spray-baffle type of washer followed by a wet disintegrator, with excellent results and with no corrosion reported.

Capital and Operating Costs

Capital costs per cfm are quite variable, influenced by the time built, whether partly built by the owner, how well built, whether built to clean the shop atmosphere or to meet an ordinance, size and number of furnaces for which equipment was installed, etc. While some companies gave their costs, these are not shown since one cannot relate them to the variables mentioned. If one is considering a control system, it would be best to secure present day estimates from several reliable companies experienced in the field.

Needless to say, capital costs should be kept as low as will give good efficiencies of collecting and cleaning emissions. The investment is not directly profitable; no worthwhile operating costs have been reported.

Miscellaneous Comments

Some of the comments noted below have been made by more than one operator. With the use of controls, the roof is kept free of dust deposits which act as insulation and shorten the roof life. With controls, floors and shop atmosphere are cleaner. Vision and working conditions are better.

Operating people are much pleased with the better and safer

working conditions. Improved community relations have resulted as well as lower maintenance costs. Several report that electrode and roof costs have not changed with controls, several report a longer roof life, one reports electrode consumption increased by 1½ pounds per ton. Roof and water cooled electrode gland changes take longer when hoods are used.

Cooling air inlets should be screened lest "operators lose their hats into them." With controls there is no effect on reducing slags. The hood interferes with making and keeping a good carbide slag, and when making one the fan is shut down. There is a tendency for slag to cool when using controls, a small increase in power corrects this. Cooling effect is related to too much air entering through tap hole and door leaks, thus cooling the slag and burning its carbon content.

Excessive Temperatures

Excessive temperatures are detrimental to bag, roof and hood life. Do not permit too little cooling air to enter the system. One operator using a hood lifts the furnace room 8 in. during lancing since the heat and smoke are "terrific." With roof-tap collecting there is no delay in changing the roof. Most operators report that there are no adverse effects caused by the use of controls. One operator reports that with hoods the furnace power is reduced from 520 to 500 KWH/ton.

Suggested Developments

Objectives of the suggestions are: to meet the ordinance requirement and to get a good economic control system which is easy to operate and which is acceptable to the workmen. These objectives can be met by obtaining information on presently operating control systems and by sponsoring investigations of items such as the following:

(a) A good hood and support design with stability of shape, low maintenance, little interference with electrode travel, ease of removal, adequate collection of emissions.

(b) Design of ceramic inserts for the par of the hood deck around the electrodes.

(c) With the roof-tap determine whether the furnace off-take elbow should be water jacketed steel or a heat resisting cast alloy, whether it can be equipped with cooling fins to eliminate water hazards, whether it can be devised for indirect air cooling. Can cooling air be admitted into the duct near the roof, thus not using water? Can water be sprayed into the off-take elbow for cooling purposes?

(d) What can be done to keep all furnace aperatures tightly closed except when necessarily open, and except for those where emissions escape and are collected?

(e) Develop a better joint between the duct from and on the furnace, and the stationary duct to the fan, so that the exhaust will be continuous when the furnace tilts.

(f) Develop comparisons between air and/or water cooling of the emissions, both directly and indirectly, and how these relate to cfm at the cleaner.

(g) Obtain data on effects of controls on electrode, roof, and lining life—on power consumption, fluxes and their performance, on quality of product.

(h) Comparisons between kinds of cleaning equipment, capital and operating costs, space needed, efficiency, guarantees.

(i) Data for various parts of a heat cycle on cfm needed and the dust loading. At each part obtain dust sample for mesh and composition.

(j) Methods of collected dust disposal and possible uses.

(k) Needing investigation are the quantity of pollutants and the cfm needed, when fuel gas and oxygen are injected into the furnace to melt the scrap charge, simultaneously with the use of electric power.

English Practices

These practices have been abstracted from Proceedings of the Air Pollution meeting, Iron and Steel Institute, London, Sept. 1957. 10 p.p.

The Act now requires a discharge no darker than Ringelmann No. 2.

During the war the discharge showed about 30 percent of the particles below 10 microns, but recently with oxygen lancing this was found to be 40 percent.

The probable maximum dust and fume per ton of raw and scrap materials charged is about 0.8 percent, and this is supported by German data.

In open hearth, the temperature and quantity of the air-gas mixture are known and under easy control. With arc furnaces, the gas escapes at many places, and the cfm varies with the design and operation of the furnace and the type of product, therefore, control is more difficult.

Various methods have been tried to collect the emissions, but all are handicapped by the tilting required and by the swing roof. A number of plants installed hoods over roof, doors and spouts. If these are too close fitting they warp. No attempt has been made to collect emissions from the electrode ports.

Roof Tap Abandoned

On a 25-ton furnace a roof-tap method was tried, then abandoned. Metallurgists report that this method cannot be used where alloys are made because it is essential to maintain pressure in the furnace. One needs to consider the large amounts of air drawn into the furnace with a negative pressure, which in turn sets up metallurgical problems.

An installation was made recently on a 19 ft. furnace, using a hood with a triangular hole in the top for the electrodes. The hood collects emissions from the doors, spouts and electrodes, 50,000 cfm was used. The hood warped, the furnace discharged more fume than could be collected. Some improvements were made by water cooling. The warping made trouble at the slip joint.

To collect the fume may require such a large power use as to be uneconomic.

A handicap is the large duct required for which no room may be available.

The choice of cleaning equipment probably lies between bag filters and electrostatic precipitators, which are discussed in detail.

This subject requires research and experience. Research on a national basis would be beneficial.

Summary

Hoods distort and require maintenance. If compelled to meet No. 2 Ringelmann, the cost would be great. Electrode consumption may increase. A roof-tap system was tried but was not successful. Extreme roof channeling was experienced, with a life of 40 instead of 68 normal heats.

Economic cleaning of fumes is not a simple matter. The rate of

(Please turn to following page)

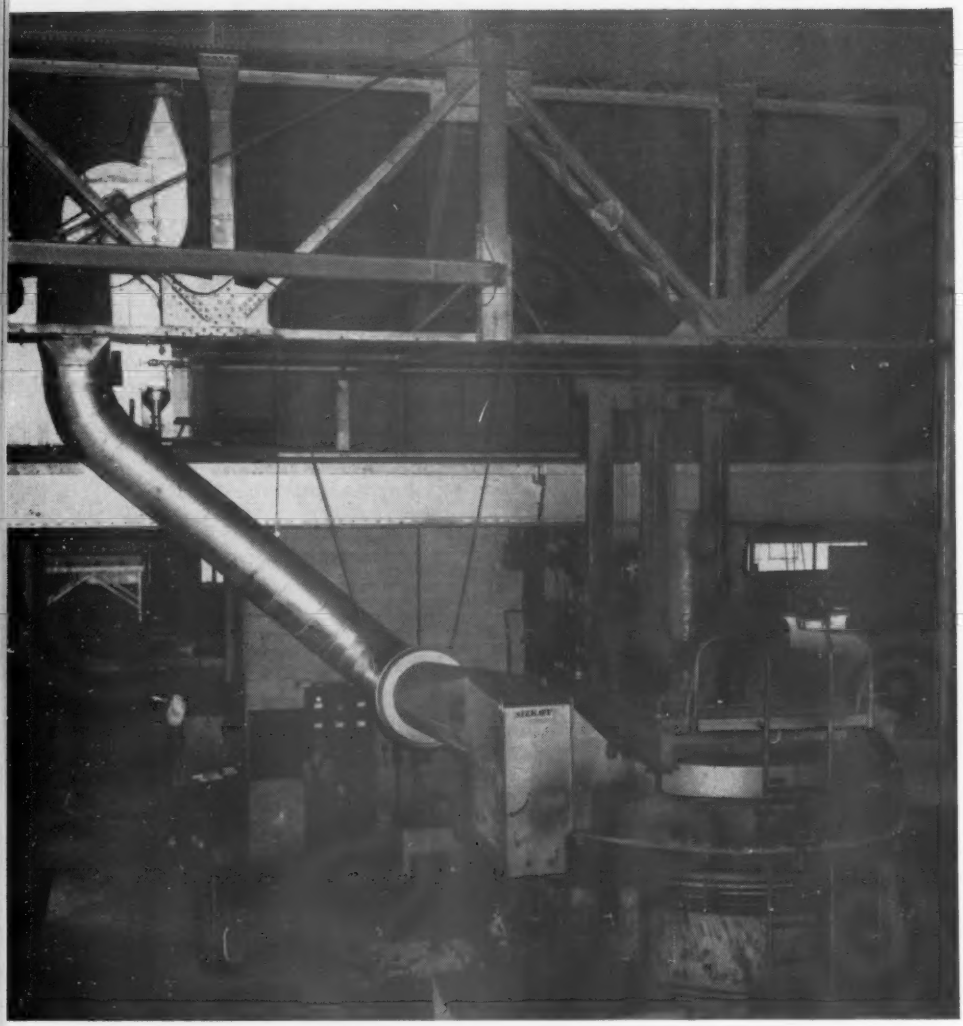


Fig. 4: *Same furnace (as shown in Fig. 3) after installation of furnace hood. Note ductwork to collector and absence of smoke or haze within melting furnace room.*

(Continued from preceding page)
emissions is very variable, the awkwardness of the electrical gear and the electrodes, the large ducts and the usual impediments in a melt shop add to the difficulty. Furnace designers should produce a melting chamber with minimum leakage. It is desirable to operate the furnace under slight pressure.

Two questions were how to bring emissions under control, and the cost. Electrode consumption increased 2 lbs/ton. What are the effects on side wall and roof life? Effect on electrode life is negligible.

Not much data is available on operating costs of control systems. One plant with 2 furnaces making 145,000 tons/year of alloy steel gives $1.26 per ton. Effort should be made to stop furnace leaks thus reducing secondary air required to remove the emissions.

Conclusions

For the most part, the hood with various modifications or the roof-tap method work as well as emission collectors. Whether to cool emissions by air, water, or both, can best be determined by the overall system economics. The emissions, mostly dust, can be cleaned by bags, by Cottrell, by water wash tower and wet disintegrator. Some of the modern improved wet washers may prove satisfactory, provided they remove the fines in accordance with requirements. No doubt, a cleaner should be used which will show little visible discharge, and since the emissions are very fine this may mean the discharge should be below .05 gr/cu.ft.

A number of companies have built and will build systems either in part or entirely.

Each furnace or installation presents separate problems, when considering controls, depending upon factors already mentioned, as well as space considerations at presently installed furnaces.

The problems are not ones for which simple solutions can be found, and there is no equipment ready from the shelf to install without modifications being required, and even after an installation is made, testing, adjusting and changes may be required to meet ordinance and shop requirements.

A number of installations have been made which work satisfactorily. With most of these later changes were found necessary. One company with 3 large furnaces stated that it took four years to develop, install, and make necessary changes on the several systems tried before one was operating satisfactorily.

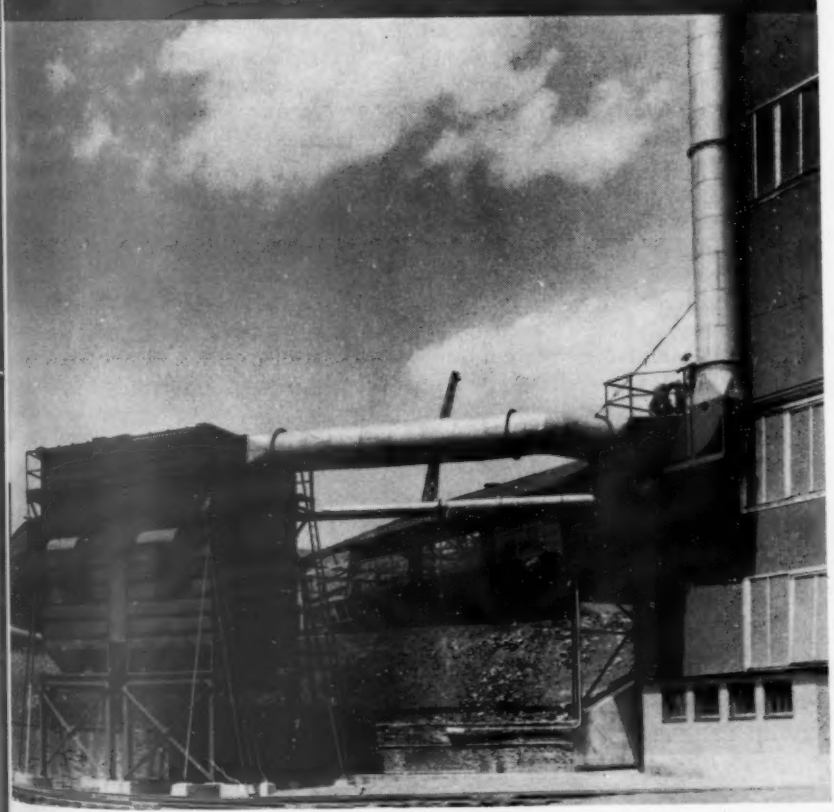
When considering controls, the operating costs need consideration to determine whether they can be afforded. To get cost information operators of present systems should be consulted, and estimates of costs should be obtained from suppliers who have already built similar installations. ▲▲

BIBLIOGRAPHY

1. Control of Metallurgical and Mineral Dusts and Fumes in L.A. County, Los Angeles, Cal. Allen,

Fig. 5: *Properly applied furnace hood is effective even during charging cycle, as shown in this view.*

Fig. 6: *Proper exhaust depends not only on furnace hood to trap smoke and fumes at source but also on an efficient collector to eliminate pollution problem. Shown is a reverse-jet fabric filter collector on furnace. Figs. 4, 5, and 6, courtesy American Air Filter Co.*



Viets, McCabe. U. S. Dept. of the Interior. *Bureau of Mines Information Circular* 7627, April, 1952.

2. Electric Furnace conference on fume control. Am. Inst. Mining & Metallurgical Engrs. Iron and Steel Div. Electric furnace conference, 1952, pp 32-60.

3. Mechanical arrangements for controlling Dust and Fume. John K. Meyer, Corhart Refractories Co., Louisville, Ky. 18th annual meeting conferences, Industrial Hygiene Foundation of Am. Mellon Institute, Pgh. 1953.

4. Dust control of electric steel foundries in Los Angeles area. E. O. Erickson. *A.I.M.E. Electric Furnace, Steel Proc.* 11,157-60, 1953. Same also in *Journal of Metals,* Dec. 1953, Vol. 5, No. 12.

5. Smoke, dust, fumes, closely controlled in electric furnaces. R. S. Coulter. Bethlehem Pacific Coast Steel Corp., Los Angeles, Cal. *Iron Age,* Jan. 14, 1954.

6. Smog Control in the Steel (Foundry) Industry, H. Dok, Los Angeles Steel Casting Co. Los Angeles, Cal. *Jour. A.P.C.A.,* May 1955. See *Am. Foundryman* Dec. 1954 for the same article.

7. Indirect benefits from a furnace fume collector. Eugene F. Anderson. Wheelabrator Corp. Foundry, Sept. 1955.

8. Properties and control of Electric-Arc Steel Furnace Fume. Brief, Rose, Stephan, of Taft Sanitary Eng. Center, Cincinnati, O. A.P.C.A. paper 56-16. Buffalo meeting May 20-24, 1956.

9. Cleaning of fumes from Arc furnaces. A. S. Hipkin, Proceedings of Air Pollution Meeting, Iron & Steel Institute, London, Sept. 1957, Special Report No. 61, 1958, pp 108-118.

10. Electric Furnace Precipitator. J. L. Venturini, Fuel Engr. Los Angeles Works, Bethlehem Pacific Coast Steel Corp. *Blast Furnace and Steel plant, April,* 1959, 371-375, 383. See also R. S. Coulter in *Iron Age,* Jan. 14, 1954.

11. Air Pollution Control and the Metal Working Industry. Fred Rehm. Air Pollution control Engr. Milwaukee Co., Wisc. *Air Engineering,* April, 1959, pp 33-37, 64.

12. Making air fit to breathe. Engineering (London) 189:174 Jan. 29, 1960. Tells briefly about disposal of elec. steel fce. collected dust.

13. Modernization of the Seattle Plant. Bethlehem Steel Co. Pacific Coast Div. Seattle, Washington. N. L. Bock, Chief Engr. and Kenneth Grant Elect. Fce. Supt. *Iron & Steel Engr.* Feb. 1960, pp 77-87.

Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, etc.

Fig. 1: *High frequency reduction furnace, processing magnesium and beryllium fluoride, has hood of sheet metal. Air velocities are 1200 to 1500, 800 to 1000, 150 to 200 and 150 to 250 fpm, at 4500 cfm. Hood entirely encloses furnace. Includes mold cooling area next to furnace. Clean mold is introduced through a door on right side and fastened to furnace.*

A primer on . . .

Practical Ways to Collect Beryllium Dust

PART IV

by A. J. Breslin and W. B. Harris
Health and Safety Laboratory
U.S. Atomic Energy Commission

Practical data on dust loading calculations, disposal, hood and duct sizing, features of collectors, rare operating and capital cost figures on installations.

PERSONAL CLEANLINESS will reduce the incidence of dermatitis. Cleanliness should be maintained by local washing whenever portions of the skin have been exposed to beryllium materials. In large installations or in any installation where the likelihood of gross contamination on the clothes and the body is great, clean work clothes should be issued daily and showers taken daily. To insure this, the locker and shower rooms should be placed so that they cannot be bypassed and provided with one-way entrances and exits.

There are no special specifications for work clothes other than that they be readily cleanable. A one-piece coverall does have the advantage that contamination will not localize around the midriff to the same degree as when a belt must be worn.

In the interest of general cleanliness, a lunch room has usually been made available for beryllium workers. However, there is no known beryllium ingestion hazard, and no aspect of beryllium toxicity suggests that eating in work areas is harmful.

At least one instance of chronic illness, in the wife of a beryllium worker, has been reported which was attributable to an exposure to beryllium while washing contaminated work clothes. Routine air samples in a beryllium plant laundry show that concentrations of 40 $\mu g/m^3$ may occur from placing batches of dirty work clothes in a washing machine.[5] This is convincing evidence that clothes contaminated with beryllium should not be sent indiscriminately to commercial laundries. The practice at beryllium facilities under AEC contracts has been to operate a laundry on the premises; these range from a single domestic washing machine to a full complement of commercial washer, extractor, and dryer units.

The accumulation of even minor unnoticed quantities of contaminant spilled over a period of time will become a generalized hazard. Continual policing by the operators is required to maintain low general air concentrations. Therefore, housekeeping should be a part of the regular work habit. Spills should be immediately cleaned by the employees who cause them.

Efficient housekeeping in large installations is best accomplished by a special janitorial staff which spends full time on area decontamination in addition to the local policing by production workers. Dust deposits on floors, walls, process equipment, ducts, and rafters must be continuously removed.

The selection of suitable cleaning methods is of great importance because many common janitorial practices disperse dust and therefore cannot be tolerated in a beryllium plant. Cleaning with brooms or compressed air will generate intolerable dust concentrations. Even on a wet floor, stiff brooms can raise significant mist concentrations. High velocity nozzles are likewise unsuitable. Mops or squeegees are more satisfactory in wet areas.

An inherently non-dust-producing device such as a vacuum cleaner is preferable for dry areas. It may be either a portable unit or a permanent system; the latter may be justified in large beryllium installations. If a portable cleaner is selected, the exhaust should be connected to the ventilation system to prevent the reintroduction of dust to the working atmosphere. A permanent system should contain a generous distribution of vacuum taps so that all work areas may be serviced. Even the operation of a vacuum cleaner, however, can be dusty unless moderate care is exercised. Concentrations as great as 6 $\mu g/M^3$ have been

easured where a vacuum cleaner as being used too energetically.

Ease of housekeeping is related to the type of interior construction: Smooth surfaces and concealed structural framework will reduce the effort required to maintain a clean work area. However, this is not essential, and the choice is primarily economic.

Normal industrial housekeeping techniques will clean surfaces well enough, the objective being to remove loose surface contamination. For dust control, there is no value in analyzing smear samples for surface contamination, since no correlation has been found between surface dust and air dust concentration. To mention an analogous case, several years ago a special effort was made to learn whether a correlation exists between radioactive surface contamination and air dust concentration, and none was found.[6]

The manner in which employees operate plant equipment is as much a part of dust control as is local exhaust ventilation. Of particular importance are specific procedural details for manual tasks. Examples of jobs which can be dusty if improperly executed are placing and removing lids from containers, handling tools in and out of hoods, transfer of in-process material, furnace charging, etc.

There are ways to do jobs of this nature with a minimum of dusting. It is important that each worker be acquainted with the best procedures and apply them consistently; rules of good operating practice must be rigidly enforced. Frequently the safest practices are tedious or require special effort. (Needless to say, best results occur where control design adds minimal operating inconvenience.) Workers will be more willing to comply with such rules if they understand the reasons for them; therefore, a program of education about known beryllium hazards is beneficial to both supervisors and workers. It should create a feeling of respect rather than fear for beryllium materials.

There is a marked tendency even for persons acquainted with the toxic aspects of materials to lose sight of their potential hazard as time passes because of familiarity, and therefore to become less careful in handling procedures. To counteract this tendency, supervisory personnel must be continuously on the lookout for deviations from good practice and must immediately censure employees who commit infractions.

In-Plant Air Monitoring

Except for waiting for evidence of overt disease, the only means of determining whether satisfactory control is being maintained is to measure the beryllium dust concentration in the environmental air. The survey of dust exposures is an integral part of dust control and may be considered as the proof testing of engineering controls. It often constitutes a basis for redesign or modifications toward better control. Any such study should be performed by a competent industrial hygienist. Basically, it will serve two important purposes: 1) provide an evaluation of the exposures of employees to beryllium and 2) enable the engineer to detect sources of contamination.

Monitoring must be performed on a repetitive basis in view of the changeability of dust concentrations in a plant. Deterioration of equipment, employee turnover, relaxation of clean work habits, process changes, and seasonal effects are factors which tend to change control effectiveness. This variability may be more or less pronounced according to the nature and size of the beryllium process. In any case, the air sampling technician should be in frequent contact with all phases of the operation so that the effects of process changes on air contamination can be quickly identified.

Any air sampling device that separates the air contaminant in a manner suitable for chemical analysis can be used for beryllium monitoring provided the sampling rate is great enough. A high sampling rate is often necessary because of the normally low beryllium concentration at an adequately controlled facility. A minimum rate of 1 cfm is recommended and higher rates are desirable. A high-volume filtration-type sampling unit possesses several characteristics particularly favorable for beryllium sampling.

Table I presents the values obtained during fabrication of beryllium metal from sintered powder. Some of the operations described were carried out only once, on an experimental basis. In some cases adequate control was found too difficult and the operation was discontinued.

Table 2 presents data collected during the handling of beryllium powders. These are prepared by chipping vacuum cast ingots on a chipping lathe (see Table 1) and

(Please turn to following page)

Table 1

Metal Fabrication

		Be concentration, $\mu g/m^3$		
		Max	Min	Median
Metal cutting, lathe operations				
Chipping	Enclosure, hi-velocity pickup	2.4	0.4	1.1
Turning	" " "	5.8	1.0	1.2
Drilling	Ventilated collar	10	4.9	8.9
Jig boring	Hi-velocity pickup	4.6	0.5	3.0
Sawing (band)	Hi-velocity chip pickup, water coolant	5.2	0.4	1.3
Milling	Hi-velocity chip pickup	7.2	0.5	0.9
Metal grinding				
Surface grinder	Enclosure, water coolant	5.3	0.2	1.1
Cutoff wheel	" " "	5.9	0.1	1.0
Centerless grinder	" " "			29*
Miscellaneous impact†				
Forge (cold)	Ventilated enclosure	30	1.7	
Shear	" "			32*
Extrusion (cold)				
Load end	Open end steel jacket	1.7	1.0	1.3
Discharge	" " " "	2.0	1.8	1.9
Discharge	Unjacketed	2.3	0.3	0.4
General machine shop air		20.0	0.1	0.6

Note: Each value represents the average of replicates collected on a single survey.
*At least three surveys except as noted.
†Dust created by manual handling rather than operation. This was a crushing operation.

Table 2

Powder Handling Operations

		Be concentration, μg/m³		
		Max	Min	Median
Powder preparation (changing containers)	Ventilated enclosure	18	1.8	7.1
Blending (small)	Hood-hand ports			4.3
Blending (large)	Booth	32	1.5	9.7
Compacting	Ventilated enclosure			0.8
Vertical sintering face	Ventilated collar			
Load		3.0	0.8	*
Unload		8.8	0.5	3.4
Die stripping	Isolated, ventilated room (respirators)	128	6.1	63
General air, furnace area		0.6	0.2	0.3
General air, powder preparation area		2.2	0.3	0.6
Chip handling				
Change receiver		12	6.3	9.1
Pneumatic transfer to drum		57	2.3	14

*Only two values.

Table 3

Metal Handling Operations

		Be concentration, μg/m³		
		Max	Min	Median
Pebble sampling (Vezin)	Ventilated enclosure			13.5
Pebble (bead) weighing	Inadequate ventilation	66	21	
Vertical-pour vacuum face				
Charging pebbles	Ventilated semienclosure	23	4.6	15
Remove billet and mold	" " "	41	19	24
Clean billet and mold	Ventilated table with backdraft	42	1.5	29
Clean crucible	" " " "	3.8	3.6	3.7
General air, vacuum casting area		4.8	3.6	2.9
Tilt-pour furnace				
Charge pebbles	Flexible exhaust duct	11	8.8	10
Pour	Ventilated collar	20	3.5	12
Remove billet and mold	Exhausted buggy	49	5.3	6.0
Remove billet from mold	Exhausted cabinet	6.2	0.5	0.9
General air, vacuum casting area		9.8	8.6	4.2
Sand blasting ingot	Commercial sandblast booth	27	2.0	2.2

(Continued from preceding page)

charging the chips into an attrition mill for grinding to a fine sieve size. The powder from the mill normally discharges into a glass container screwed to the discharge spout.

Powders of various analyses are blended and charged into a steel compact die, which is then welded, loaded into a sintering furnace, and sintered under heat and pressure. The steel die is later stripped from the final compact. Again it should be pointed out that the data presented show breathing zone concentrations under a particular set of circumstances. Some of the values represent actual exposure to the employee, others do not, because the employee was protected by a dust respirator.

Table 3 lists operations involving the handling of beryllium pebbles and casting pebbles into ingots.

Table 4 presents data gathered during operations involving beryllia. It is important to note that the operations specified in the table vary greatly in magnitude,

(Please turn to page 62)

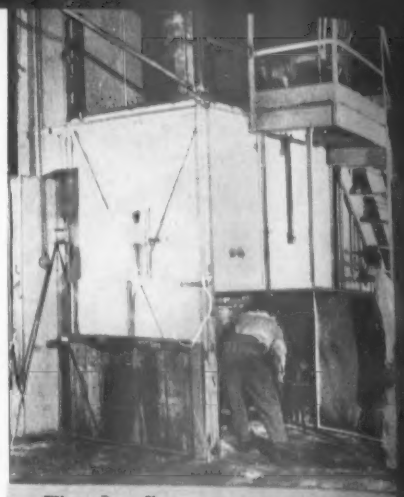


Fig. 2: *Same furnace as in Fig. showing how furnace is charged a special hood at top of main closure shown here. Drum hood contains beryllium fluoride. may be tilted to dump into furn by means of crank arrangement (n shown).*

Fig. 3: *Production type carbon a tilting furnace for crushed ber Sheet metal hood handles 5800 cf Hood is attached rigidly to furnac connecting branch duct has two r tatable elbow joints. Exhaust coll provides ventilation at open top furnace and canopy ventilates po spout. When furnace is upright, exhaust air is drawn through coll When furnace is tipped, a gravi actuated damper diverts a part of t air to canopy hood. Molten ber pours through a water stream a into water tank, for quenchin Fumes and steam are collected the canopy hood.*

For "White Rooms," latest methods of . . .

"Fingerprinting" Airborne Dusts

By D. P. Hoffman, *Convair (Astronautics) Division General Dynamics Corporation, San Diego, Calif.*

It's often helpful to trace the source of dust that troubles a "super-clean" area, to stop dirt at point of emission. This article tells how to identify and track down these dust particles, on a "do-it-yourself" basis.

Fig. 1A: *Dusts from distant sources in the plant can plague critical super-clean areas like this. Photo shows portion of special electronic assembly area with solder pot exhaust system. Photo courtesy McDonnell Aviation Corp. (There will be a full scale story on the McDonnell White Rooms in the November issue of AIR ENGINEERING.)*

LIVING IN A SEA OF DUST PARTICLES as we humans do, it is understandable why we generally ignore them. Usually, dust plays the role of a minor nuisance and little thought is given to its origin, method of transportation, chemical nature or physical properties. To a person responsible for the successful operation of a valuable piece of equipment, however, particle contamination can be a nightmare. With Benjamin Franklin's horseshoe nail in mind we might say: Because of some particles, a diaphragm was lost; because of the diaphragm, a pressure system was lost; because of the pressure system, an expensive piece of precision equipment was lost.

Locating the source(s) of particle contamination is a task which must be completed before deciding how to eliminate that contamination most effectively.

Each particle in a given contamination has a unique history. It frequently happens that all or most of the particles in the contamination have the same or similar immediate origin; but this cannot be taken for granted. Also, the origin of the particles is not always easily traced.

To locate the source of the contamination it is helpful, if not mandatory, to learn something about the chemical nature and physical properties of the contamination. Sometimes rapid microscopic observation of the contamination is enough to establish its nature and indicate its source. Frequently, further testing is necessary. A variety of instruments and techniques is employed to discover such properties as particle size distribution, particle type distribution, chemical elements present, and types of molecules present. At Convair (Astronautics) Division of General Dynamics Corporation we are using the optical microscope to determine particle size and type distributions, the emission spectograph to determine chemical elements present, and the infrared spectrophotometer to determine types of organic molecules present in a given contamination.

(Please turn to following page)

CONVAIR ASTRONAUTICS

Report 27E 165
Page (5)

DATA SHEET USED TO RECORD PARTICLE TYPES AND SIZES

PLATE NO. MTL 9 BLDG. 5 SAMPLE AREA Station 2 Dock L10

DATE PLACED 3 April '59 DATE REMOVED 7 April 1959 (4 days)

VISUAL OBSERVATION: Sample Acceptable (Photograph taken April 7, 1959)

PLATE AREA SAMPLED Total TOTAL POPULATION 7,092,000

FIBERS – PARTICLES WITH LENGTH – 10 x WIDTH – 152,000 Particles/Sq. Ft./Hr.

SIZE MICRONS	WHITE PLASTIC-LIKE	SHINY MET. LIKE	DULL METALLIC	MISCELLANEOUS FIBERS TOTAL		
1-16	16.0%	29.5%	9.5%	8.0%		63.0%
16-32	5.0%	7.5%	1.5%	3.5%		17.5%
32-85	2.0%	4.5%		2.0%		8.5%
85-230	0.5%	1.5%		0.5%		2.5%
230-460				0.5%	0.5%	1.0%
460-920					0.5%	0.5%
7920					7.0%	7.0%
TOTAL	23.5%	43.0%	11.0%	14.5%	8.0%	100.00%

Fig. 1: *Form used to record particle types and sizes.*

(Continued from preceding page)

Airborne dust is always a suspect in any case of particle contamination. As in most detective stories it is helpful to have fingerprints of the suspects as an aid in finding the criminal, so it is helpful to have "fingerprints" of airborne dust on file so that they may be compared with the "fingerprints" of a given contamination. In this way airborne dust can either be nominated or eliminated as one of the culprits. In this discussion we will concern ourselves with three types of airborne dust "fingerprints"; particle size and type distributions, and the relative average concentration of metallic elements present.

There are many methods available for collecting samples of airborne dust. The method we chose for our study of the factory building at Convair-Astronautics was the greased plate impinger method[1]. Pieces of 7-in. x 10-in. glass plate were covered with 10 ml. of a solution of white petrolatum in petroleum ether. Evaporation of the petroleum ether left a film of the white petrolatum on the glass. These grease coated glass plates were then placed at nine different locations within the factory building.

The airborne dust settled on the plates and was retained by the grease film. After an exposure of three or four days, the plates were returned to the laboratory and freshly prepared plates were put in their places. This dust sampling continued for eight weeks.

Upon being returned to the laboratory after exposure, the plates were rinsed with trichloroethylene which had been filtered through Millipore filter membrane*. This filter membrane was designed to retain particles greater than 0.45 microns. These rinsings were funneled into a particle clean Pyrex glass bottle, and diluted to one liter with filtered trichloroethylene. The bottle was stoppered and shaken vigorously.

Enough of this agitated sample was filtered through a membrane to get a sample of the particles which was relatively easy to count under the microscope. The remainder of the agitated sample was filtered through another filter membrane and the particles which were retained were subjected to emission spectrographic analysis.

Seven size categories were chosen for microscopic counting of the particles; 1-16μ (microns), 16-32μ, 32-85μ, 85-230μ, 230-460μ, 460-920μ, and >920μ. The size of a particle was determined by comparing its greatest dimension with the calibrated microscope reticle.

Although the particle type categories are quite qualitative, the particles were each placed in one of the following: white plastic-like, dull metallic-like, shiny metallic-like, miscellaneous, and fibers. A fiber was arbitrarily defined as a particle whose length was greater than ten times its width.

The counting data gathered for each sample was recorded on a data sheet as illustrated in Fig. 1. There are various methods for selecting a small random sample of the particles for counting. We chose to start counting at an edge of the filtered surface of the Millipore membrane. We continued counting all particles in the microscopic field of view, moving the field toward the center of the membrane.

When exactly 100 or 200 particles had been counted and recorded on the data sheet, the exact number, depending on the total population of the membrane, the counting was discontinued. Calculations were thus simplified since the number of particles found in any type-size category was either the exact percent or twice the percent of the total number of particles counted. When the eight-week sampling period was over, more than 100 samples had been counted, a minimum of seven samples at each of the nine sampling stations in the factory building.

At each sampling station, the percent of the particles found in each type-size category compared to the total counted was averaged over the total samples taken. The particle fallout rate was also averaged. Four of the sampling stations were non-enclosed areas and the greased plates were placed on tables three ft. above the floor level. One of the sampling stations was thirteen feet above floor level, also non-enclosed. At the three enclosed sampling stations two plates were five feet above floor level, and one was three feet above floor level.

It was observed that all the non-enclosed sampling stations three feet above floor level had very similar fall-out rates. A graph was constructed (Fig. 2) of log particle fall-out rate vs. log particle diameter (greatest dimension). One sampling station was chosen to represent all the non-enclosed sampling stations. Likewise, one sampling station was chosen to represent all the enclosed sampling stations on this graph. From this graph the particle fall-out rate for particles of a given diameter can

*Made by the Millipore Filter Corp., Bedford, Mass.

e easily found to a good approxiation for any location in the facry building.

Fig. 3 is a graph of log particle all-out rate vs. particle type. ince particle type is not a conuous function, the connecting es in this graph are for the le purpose of easily comparing n-enclosed, elevated and enosed sampling stations. From is graph the particle fall-out te for particles of a given type n be easily found to a good approximation for any location in e factory building.

Figs. 2 and 3 contain a large rt of the experimental data eeded in deciding whether conruction of special dust controlled reas is necessary for certain facry operations.

Figs. 4, 5 and 6 are graphs of particle type as a function of particle size for non-enclosed, elevated and enclosed sampling stations, respectively. As previously mentioned, particle type is not a continuous function, therefore there is one curve for each of the five type categories. Each of these curves shows how the percent of the total particles present for a given type category changes with particle size. Close observation of Figs. 4, 5 and 6 reveal marked differences in the shapes of the curves between enclosed, non-enclosed and elevated sampling stations. Figs. 1 through 6 constitute half of our airborne dust "fingerprints."

Spectrographic analysis of the dust samples was performed using the method outlined by A. J. Mitteldorf[2].

As a result of these analyses the dust samples were found to contain thirteen metallic chemical elements in significant quantities. Due to the analytical method employed, the concentrations of the metallic elements found in each sample were estimated to an order of magnitude. As might be expected, some of the samples revealed the presence of all thirteen elements, while for others some of the elements were not detected.

The logarithms of the metallic element concentrations were calculated for each sample. For each sampling station these concentration logarithms were averaged for each of the thirteen elements. Since most of these logarithm averages turned out to be negative (none less than -5.0) a +5.0 was added to each to make all the resulting numbers positive. In this way, a large numerical value for the concentration represents a high relative concentration. Thus, chances for misinterpretation of the relative concentrations are reduced.

For each element the log concentration of +5.0 values were averaged over all the sampling stations. Fig. 7 presents the results of all these calculations with the elements ranked from high to low according to their relative average order of magnitude concentrations. Fig. 7 constitutes the other half of our airborne dust "fingerprints."

Just as the prosecution must weave a web of circumstantial evidence to ensnare the criminal when there are no witnesses to the crime, so it often becomes necessary to weave a similar web of circumstantial evidence to find the source of a contamination. Let us see what web can be woven to find the main source of our airborne dust. This will illustrate the use of our "fingerprints."

Four samples of the airborne dust falling outside the factory building were taken. Particle counts and spectrographic analyses were performed and the results were as follows:

PARTICLE SIZE DISTRIBUTION

Size Range (microns)	Percent of Total
1-16	60.8
16-32	24.7
32-85	12.4
85-230	2.0
230-460	0.0
460-920	0.0
920	0.1

PARTICLE TYPE DISTRIBUTION

Type Category	Percent of Total
white plastics-like	36.4
dull metallic-like	3.8
shiny metallic-like	16.2
miscellaneous	43.5
fibers	0.1

RELATIVE AVERAGE CONCENTRATION ORDER OF MAGNITUDE OF METALLIC ELEMENTS

Element	Concentration Number
silicon	5.5
iron	4.8
titanium	4.3
aluminum	3.9
copper	3.9
magnesium	3.7
chromium	1.8
nickel	1.7
silver	1.0
manganese	1.0
zinc	1.0

Particle Fall-out Rate

2.9 $\times 10^5$ particle per square foot per hour.

Comparing these results with Figs. 1 through 6, the notable differences are: (1) A significantly larger fiber count inside than outside the factory building, and (2) a much larger fraction of shiny metallic-like particles inside than outside the factory building.

Comparing the ranks of the elements with respect to relative average concentration order of magnitude there is a striking similarity. Notable exceptions are copper which is an order of magnitude higher in relative concentration inside than outside, and silicon which is higher outside than inside the factory. It is also interesting to find that the particle fall-out rate at non-enclosed stations inside is for all practical purposes identical to that outside the factory.

Thus, there is fairly strong evidence to indicate that a large portion of the airborne dust inside the factory comes from the immediate area outside the factory building.

Before completion of our dust study we were faced with a perplexing problem. Some important components were being processed. Successful operation of these components required that there be a relatively low level of particulate contamination present.

As hard as we tried to clean these components, we were continually faced with a level of contamination much above that which could be tolerated. Spectrographic analysis of samples of the contamination revealed a very high concentration of copper. Upon checking most of the possible sources of contamination, there seemed to be no way that copper in any concentration approaching that observed could enter the components. When we finally compared the high copper concentration of the contamination with the spectrographic results from the airborne dust, we thought we finally had the answer.

Many people contributed timely suggestions during this study. I am especially indebted to Mr. Harry Lusk for his patient particle counting and the origination of the particle counting data sheet,

(Please turn to following page)

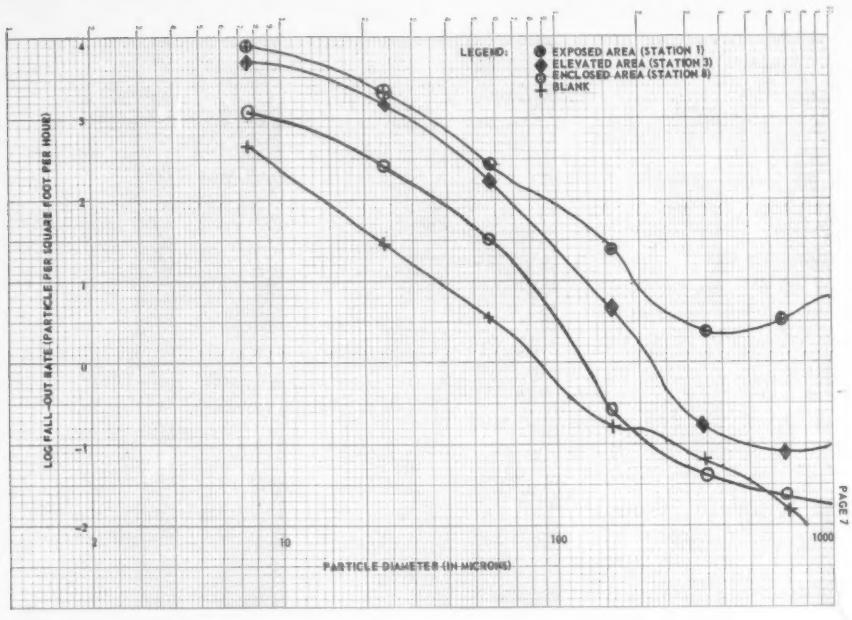


Fig. 2: *Particle fall-out rate as a function of particle size.*

Fig. 3: *Particle fall-out as a function of particle type.*

(Continued from preceding page)

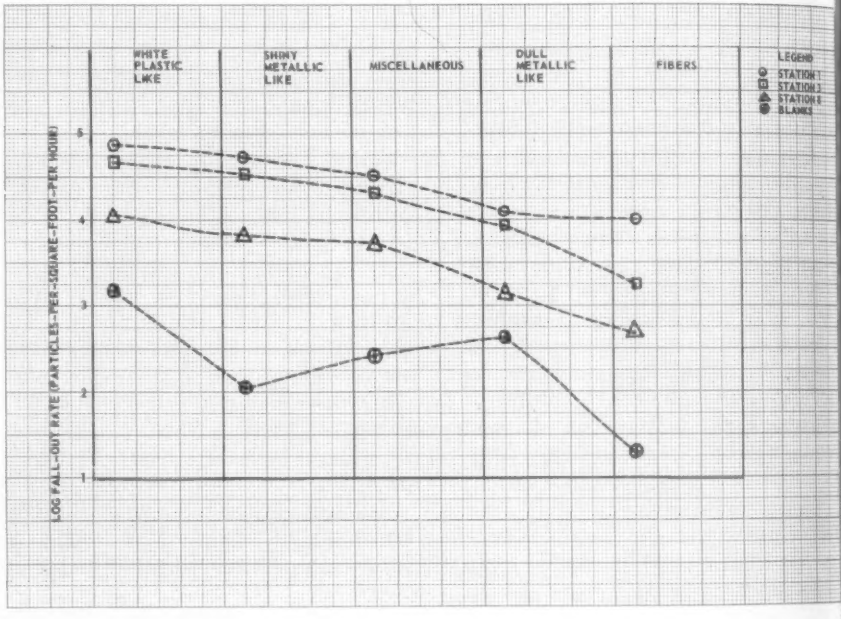
Convair . . .

and to Mr. George Humel for the spectrographic analyses. Many thanks to Dr. G. J. Goble for much inspiration and vision.

BIBLIOGRAPHY

1. R. L. Pond and R. R. Paxton, *Analytical Chemistry*, Vol. 27, 714-16 (1955).

2. The Spex Speaker, Vol. II, No. 2, April, 1957, published by Spex Industries, 205-02 Jamaica Avenue, Hollis 23, New York. ▲▲



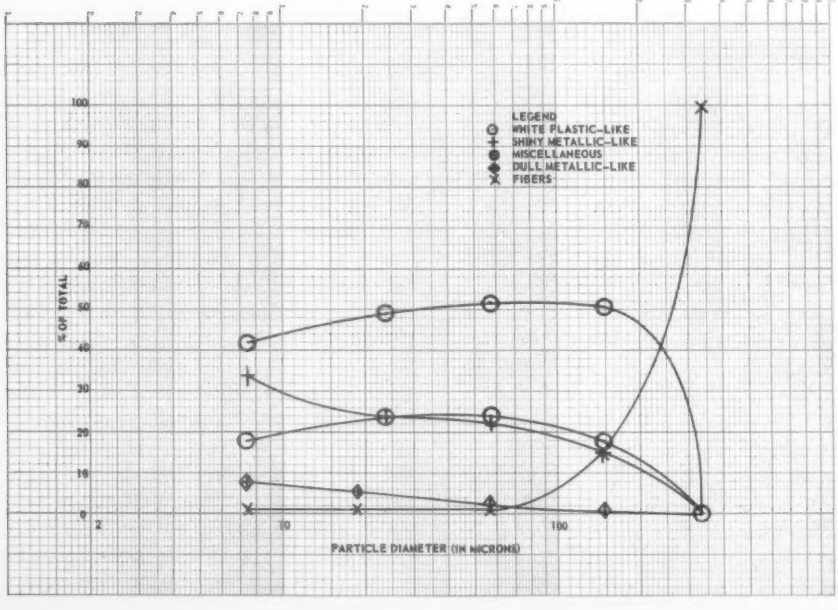


Fig. 4: *Particle type as a function of particle size (exposed area), station No. 1.*

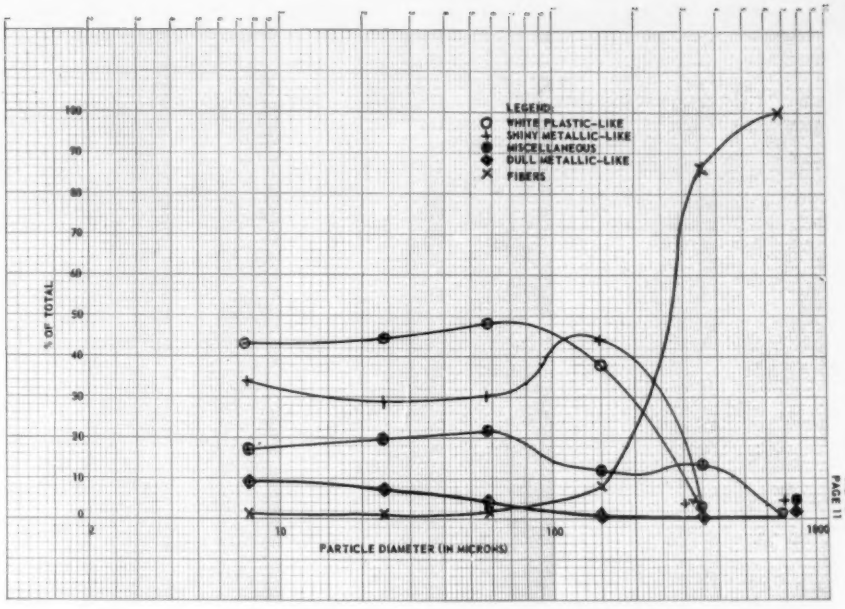


Fig. 5: *Particle type as a function of particle size (elevated area), station No. 3.*

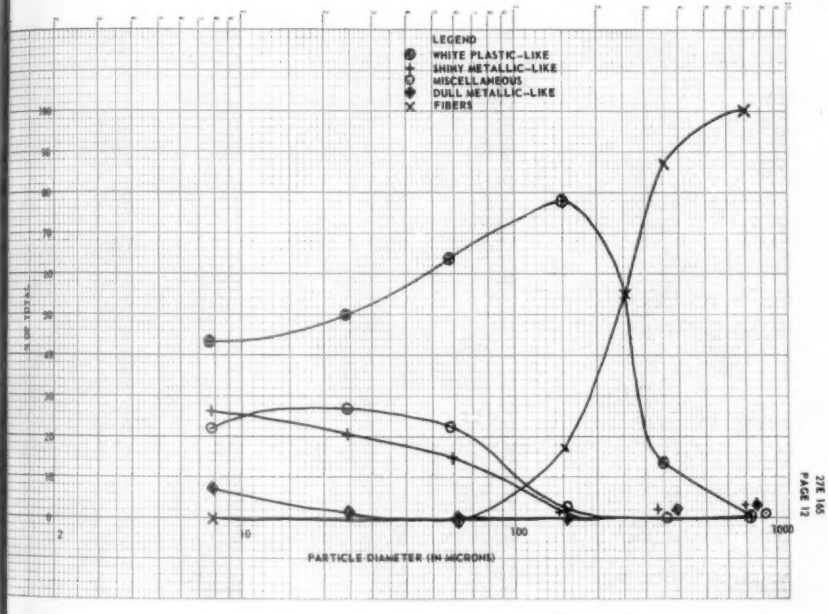


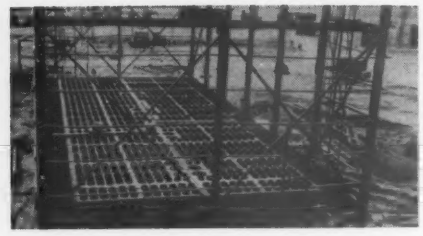
Fig. 6: *Particle type as a function of particle size (enclosed area), station No. 8.*

FIG. 7—RANK OF DETECTED ELEMENTS ACCORDING TO THEIR RELATIVE AVERAGE CONCENTRATION

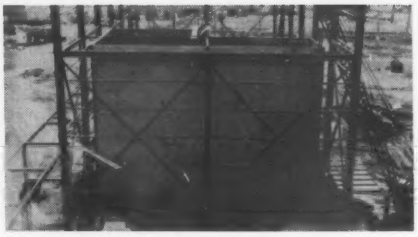
Rank	Station No. 1 SYM* RAC*	2 SYM RAC	3 SYM RAC	4 SYM RAC	5 SYM RAC	6 SYM RAC	7 SYM RAC	8 SYM RAC	9 SYM RAC	Factory Average SYM RAC
1	Cu 4.5	Cu 4.5	Si 4.7	Cu 4.8	Ti 4.8	Cu 4.7	Ti 4.8	Si 4.2	Cu 3.9	Cu 4.9
2	Fe 4.5	Ti 4.4	Fe 4.5	Ti 4.5	Cu 4.7	Ti 4.7	Si 4.4	Cu 4.0	Si 3.8	Si 4.8
3	Si 4.3	Si 4.4	Cu 4.3	Si 4.3	Si 4.7	Al 4.5	Cu 4.3	Mg 3.0	Ti 3.7	Fe 4.4
4	Mg 3.9	Fe 4.3	Al 4.1	Fe 4.0	Al 4.3	Si 4.5	Al 4.2	Ti 3.5	Fe 3.5	Ti 4.2
5	Ti 3.7	Al 3.9	Ti 4.0	Mg 3.9	Mg 4.2	Fe 4.4	Fe 4.1	Fe 3.2	Mg 3.1	Mg 4.1
6	Al 3.6	Mg 3.8	Mg 3.8	Al 3.6	Fe 3.5	Mg 3.8	Mg 3.4	Ag 2.1	Cr 2.9	Al 3.5
7	Sn 2.3	Ag 2.8	Ni 3.0	Mn 2.5	Ni 3.2	Ni 3.6	Cr 3.1	Cr 1.5	Al 2.4	Cr 2.5
8	Ag 2.2	Ni 2.3	Cr 2.8	Ag 2.4	Mn 2.8	Cr 2.8	Ag 2.6	Al 1.3	Ag 2.2	Ag 2.3
9	Cr 2.0	Cr 2.1	Ag 2.6	Cr 2.4	Cr 2.7	Ag 2.3	Pb 2.3	Zn 1.0	Pb 1.4	Ni 2.1
10	Pb 1.5	Zn 1.7	Mn 1.8	Ni 1.9	Ag 1.7	Mn 2.3	Ni 2.1	Pb 0.9	Zn 1.1	Mn 1.6
11	Mn 1.4	Mn 1.2	Pb 1.7	Pb 1.9	Pb 1.3	Pb 1.6	Mn 1.5	Mn 0.6	Ni 0.7	Pb 1.5
12	Ni 1.4	Sn 0.8	Zn 1.2	Zn 1.2	Zn 0.9	Zn 1.2	Zn 1.3	Ni 0.3	Mn 0.5	Zn 1.1
13	Zn 0.5	Pb 0.7	Sn 0.5	Sn 0.4	Sn 0.7	Sn 0.4	Sn 1.0	Sn 0.3	Sn 0.2	Sn 0.7

*SYM: *Symbols of the detected chemical elements.*

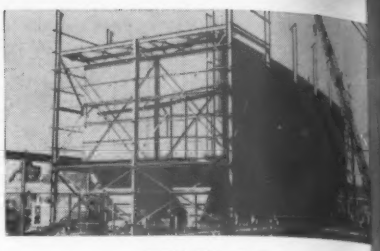
• RAC: *Relative average concentration orders of magnitude.*



MAY 7



MAY 13



MAY 14

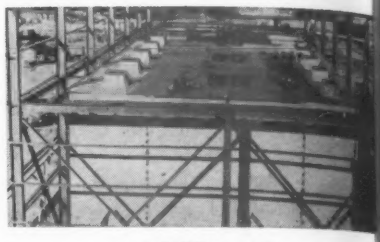
Step By Step . . .

A Bag House Goes Up!

THE FOLLOWING PICTURES show progressive stages in construction of a high temperature filter bag type of dust collector constructed for Columbia-Southern Cement at Barberton, Ohio. This type collector utilizes glass fiber siliconized filter bags capable of handling gases up to 550°.

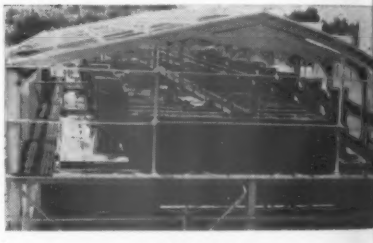
● *May 7:* Round bag connection collars for bag house shown in place on operating floor. ● *May 13:* Section walls rise within general frame work. Walls are prefabricated and crane places them in position. ● *May 14:* Last walls of sections go into position. Workmen are on operating floor at access doors to various sections. ● *June 11:* Top structure of bag house being installed. Square ducts are outlets for cleaned air, round ducts in center are inlets for dust laden gas from kiln. These latter ducts take gases to hoppers of bag house. ● *June 15:* Outlet ducts for bag house cleaned air are installed. Lower ports are for air exhaust, upper ports for atmospheric air inlet during bag collapsing cycle. At Columbia-Southern, bag house operates under negative pressure. ● *June 19:* Inlet and outlet ductwork installed. Photo shows dust laden inlet. Opposite end of duct is cleaned air outlet. One duct is placed within other. ● *June 25:* Outside housing goes up as stack begins to take shape in right foreground. Fan is located between bag house and stack base. ● *July 1:* Bag house completed. Outlet duct for cleaned air will run from two openings at top of housing to fan at ground level. In many cases cleaned air from bag house is exhausted directly into the atmosphere. At Columbia-Southern plans called for a stack with the unit. Air is cleaned to virtually 100 percent purity when released from bag house and product recovery is equally complete.

Photos courtesy of Western Precipitation



JUNE 11

JUNE 15



JUNE 19

JUNE 25

JULY 1

Chemical Ventilation . . .

(Continued from page 41)

ake is usually discarded and the transfer and/or ischarge of the filter cake into containers for disosal may require additional ventilation, if residual xic or irritating substances remain in the filter ake. Hood design depends on individual operation.

If filter cake is discharged into drums or a tote ox, these may be enclosed in a booth-type hood with minimum opening. A control velocity of 100 fpm hould be maintained across the hood opening to alize control. Transfer equipment, such as belts, d screw conveyors, should be enclosed and venti- ted to maintain an indraft on the casings. The vy hood and open-tee type of ventilation will sually provide the desired indraft and control.

A top feed rotary vacuum filter is available commercially. The product to be filtered is fed to the p of the rotating drum. Control can be accomlished by using the booth enclosure similar to the ne shown in Fig. 4.

Several types of continuous horizontal vacuum lters are utilized in the chemical industry. One consists of an endless porous belt or a belt equipped with compartmented trays having porous bottoms. Vacuum is applied to the porous medium during lter and wash cycles. The filter cake is discharged y gravity, air pressure or water sluicing at the end f the belt.

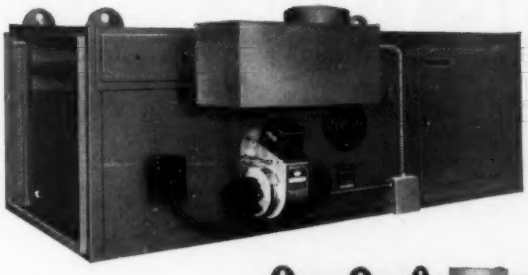
Exposure to toxic or irritating gases, mists and apors may occur during filtration washing and disharge operations. This type of continuous filter is ften relatively wide and control of gases, mists, nd vapors is best accomplished by hood enclosure. Fig. 5 shows the general design of a continuous orizontal, endless, belt vacuum filter and a hood nclosure to control contaminants liberated during ltration.

Same figure shows the hood located close to the lter top. Larger openings may be utilized. A conrol velocity of 100 fpm across the hood opening, sually provides the desired control. The enclosure ay be designed to encompass the entire filter opration if necessary.

In operations where the filter cake is sluiced from he trays, there is usually no exposure problem and entilation is not necessary. If the filter cake is disharged into tote boxes or drums, enclosure of the ischarge operation may be required similar to that hown in Fig. 4.

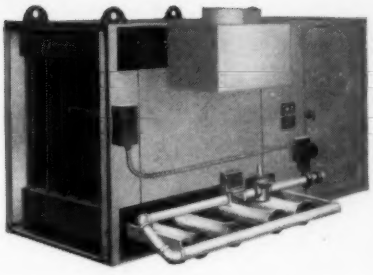
The final type of horizontal vacuum filter consists of a rotating horizontal disc, the face of which porous. Vacuum is applied beneath the face. ood enclosure of the entire filter represents the est method of control. An enclosure similar in rinciple to the one shown for the belt-vacuum, endss, filter should be utilized with a face velocity of 00 fpm through the hood openings. ▲▲

J-C SUSPENDED FURNACES are engineered for EXTRA POWER



Oil-Fired Suspended Model No. OL-350-S22, 224,000 Btuh output.

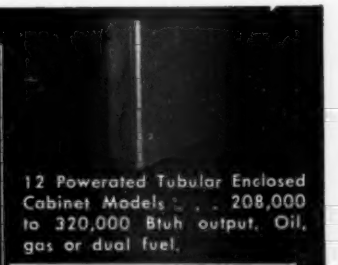
Gas-Fired Suspended Model No. GS-24, 192,000 Btuh output.



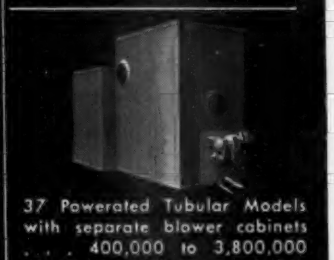
New and practically unlimited zone-heating possibilities, plus a saving of valuable floor space and easy installation are yours with the great 23-model line of Jackson & Church Gas and Oil-Fired Suspended Heaters . . . all the way from 123,000 to 1,000,000 Btuh output. Find out about J-C's *extra* fuel economy and extra power to deliver an extra volume of air against abnormal static pressure. Update your files with current specs. Write today.

J-C AMERICA'S LARGEST AND MOST COMPLETE WARM AIR FURNACE LINE.

Direct-Fired Unit Heater, 400,000 to 2,000,000 Btuh output. Floor-mounted, suspended, inverted models. Oil, gas or dual fuel.



12 Powerated Tubular Enclosed Cabinet Models . . . 208,000 to 320,000 Btuh output. Oil, gas or dual fuel.



37 Powerated Tubular Models with separate blower cabinets . . . 400,000 to 3,800,000 Btuh output. Oil, gas, dual fuel, or stoker firing.

J-C DIVISION OF JACKSON & CHURCH YORK-SHIPLEY, INC. YORK, PENNSYLVANIA

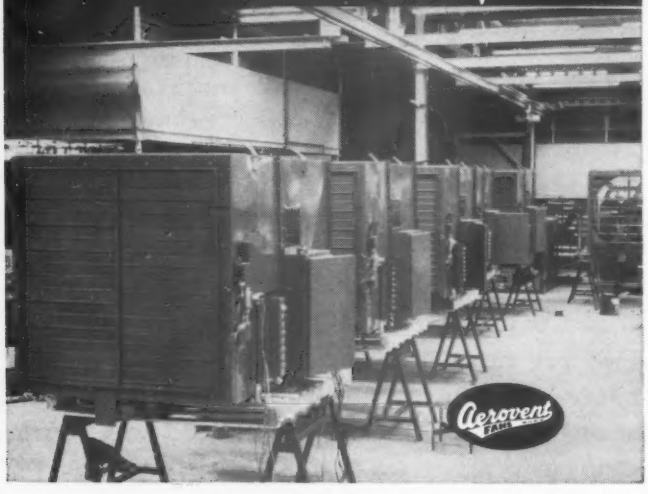
Pioneers and Specialists in Automatic Heat. Boilers to 600 hp. Furnaces to 4,750,000 Btuh

increase production capacity . . .
improve fan and heating efficiency

with

gas-fired

air
make-up
units



Pictured above is a portion of the final assembly line at Aerovent showing 8 units slated for delivery to a large Midwestern automobile accessory manufacturing plant. Designed to supply ample quantities of clean, pre-heated or cool, outside air to replace air exhausted by ventilating systems, the Aerovent Gas-Fired Air Make-Up Unit keeps air fresh; eliminates drafts and negative pressures. Safe, dependable operation and automatic, semi-automatic or manual control with natural, mixed, manufactured or propane gas.

For winter or summer use, these compact, packaged units are available in four unit arrangements and four sizes from 36" to 54" for various capacities, BTU ratings and pressure conditions.

Write for bulletin 880.

OTHER UNITS AVAILABLE FOR STEAM OR HOT WATER

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent

FAN COMPANY, INC.

Ash and Brian Streets Piqua, Ohio

Letters

(Continued from page 4)

in the photograph mentioned above, a man is actually walking along on the ground, and he is not even "leaning against" the wind as one naturally leans in a high wind. Besides, two other men are dangling from ropes attached to the top of the tank, making an heroic effort to keep the tank from blowing over. Their "direction of dangle" is practically vertical, which is very remarkable indeed when we know, in view of the above computations, that the wind velocity is 500 mph and the pressure against their rounded bodies would be computed on the basis of 625 lbs./sq ft. of projected area. They are *strong* men indeed. And the walking man must be a very *heavy* man, or he would be blown away.

In general practice in the United States it is customary to use 50 lbs./sq. ft. wind pressure as the highest that need be considered. In some sections of the South, as at Cape Lookout, N. C., it would be advisable to use a higher figure. At 104 mph the pressure on a flat vertical surface would be 54.3 lbs./sq. ft.

The maximum wind velocity ever recorded in the United States, so far as the writer has been able to determine, was 231 mph — on top of Mt. Washing-

Don't be disappointed next month - - -

Send in your subscription NOW for

AIR ENGINEERING

Write on your letterhead or use the handy order card in this issue. Be sure and state your company affiliations and job title.

Circulation Manager
AIR ENGINEERING
450 West Fort Street
Detroit 26, Michigan

1 year, $3.00 — 2 years, $4.50 — 3 years, $6.00

ton, N. H., on April 12th, 1934.

W. F. Schaphorst, M.E.
Newark, N. J.

Wants More Ion Data

With reference to your article on negative ions (p. 13, March, 1960) I would like to see more articles on this subject, especially with reference to air conditioning.

Also, with respect to air pollution, what concentration of negative ions exist in free air . . . how is ion concentration measured, etc?

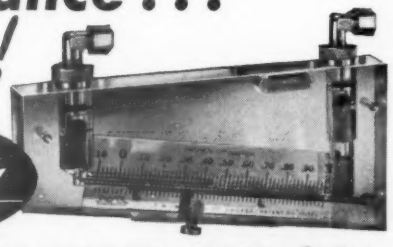
J. R. Metzler
Technician
U.S. Weather Bureau
Reno, Nev.

Editor's Note:

First, we are preparing a thorough article in depth on all aspects of negative ions. With respect to the second part of Mr. Metzler's letter, how is ion concentration measured, we welcome suggestions from readers on this subject.

We also have another reader who wants to know where he can buy a commercial scale negative ion generator. Since we know of no firm who makes a large negative ion generator for installation in larger commercial air conditioning systems, we welcome any information as to source of these units.

FILTER EFFICIENCY
at a glance . . . anytime!



Dwyer

AIR FILTER GAGE

With the Dwyer Air Filter Gage you can be sure of maximum filter efficiency because you know the *exact* time to replace filters, *every time.* Gives a continuous, accurate check that spots inefficient filters, yet prevents waste through premature replacement.

The Dwyer measures filter efficiency the only practical and economical way—via pressure drop. Quickly pays for itself through savings in replacement and service time and greater operating efficiency.

Break-proof plastic construction, lifelong accuracy, simple installation, no moving parts to ever wear out or get out of adjustment. Ranges 0-½", 0-1", 0-2" and 0-3" water. A complete unit with all necessary tubing, fittings, etc.

Write for Bulletin C10

F. W. DWYER MFG. CO.

P. O. BOX 373-A • MICHIGAN CITY, INDIANA

JUST OFF THE PRESS!

INDUSTRIAL VENTILATION MANUAL

- New information on low volume, high velocity systems!
- New hood design diagrams!
- New pressure-volume-horsepower curve for fans!
- New tables of corrosion resistant properties of plastics!
- Revised section on testing of ventilation systems!
- New material on radiant heat!
- New high temperature and low temperature psychrometric charts!

Here's the biggest and best Industrial Ventilation Manual yet — hundreds of diagrams, scores of ventilation tables and charts. It contains all the up-to-date information needed for the design of complete industrial ventilation systems. The Manual is the official publication of the American Conference of Governmental Industrial Hygienists; the recommended practices are approved by Federal, State and Municipal Industrial Hygiene Departments. Order your copy of the 1960 edition now.

JUST $4 — MAIL COUPON TODAY!

Committee on Industrial Ventilation
P. O. Box 453, Lansing 2, Michigan

Enclosed please find $_____ for _____ copies of the new 6th edition of the Industrial Ventilation Manual.

Name_____

Firm_____

Address_____

City and State_____

HARD BACK COPIES AVAILABLE AT $7.00 EACH

Beryllium Dust . . .

(Continued from page 50)

in some cases being on a small laboratory scale and in others involving large quantities of material.

Table 5 includes miscellaneous chemical and furnace operations. Most of these derive from work performed in a single metallurgical plant, but certain other data are given. In the case of manual handling, the samples represent the averages of breathing zone levels. Where no breathing zone sample is shown, it was possible to gather data from only the general atmosphere because of the automatic nature of the operation.

In Table 6 are the data from miscellaneous operations encountered in beryllium processing. It should be noted that these do not represent ideal conditions but are the actual results obtained.

Table 7 is a list of auxiliary operations related to plant services.

Table 4

Beryllia Operations

		Be concentration, $\mu g/m^3$		
		Max	Min	Median
Calcining $BeSO_4$ to BeO, beehive furnace	Slot hood			
Charge		14	0.5	
Unload		336	4.7	
General air		0.9	0.2	0.5
Fused BeO, fusion furnace	Ventilated enclosure			
Manual charge				3.6
Pneumatic charge		4.6	1.6	3.1
Clinker break-up				3.5
Crushing BeO				
Jaw crusher	Ventilated feed	38	0.7	19
Roll crusher	Ventilated enclosure	5.3	2.7	4.0
Ceramic operations	Chemical hood			
Mixing slip				0.5
Shaping form				0.6
Tamping powder	Downdraft hood			2.3

Summary

The maximum permissible concentration of beryllium in the air which has been set at more than a factor of 10 below that of any other metal, imposes an extremely rigid degree of engineering control on any plant involved in its use. The fact that there are two distinct types of respiratory illness caused by beryllium, an acute and a chronic disease, creates the additional restriction that there be two different permissible levels; one based on long term exposure and the other based on a single short term dose.

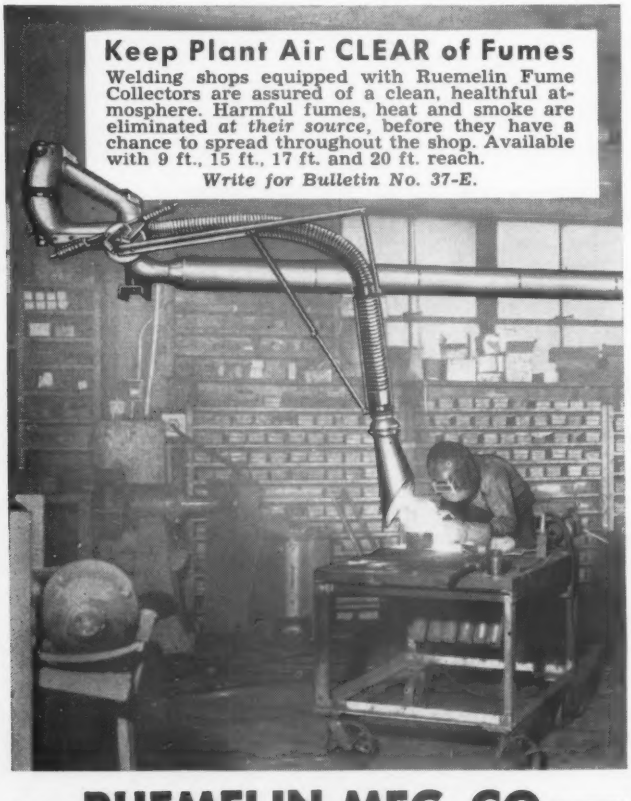
Among the engineering tools which have been used in the con-

(Please turn to page 64)

Keep Plant Air CLEAR of Fumes

Welding shops equipped with Ruemelin Fume Collectors are assured of a clean, healthful atmosphere. Harmful fumes, heat and smoke are eliminated *at their source*, before they have a chance to spread throughout the shop. Available with 9 ft., 15 ft., 17 ft. and 20 ft. reach.

Write for Bulletin No. 37-E.

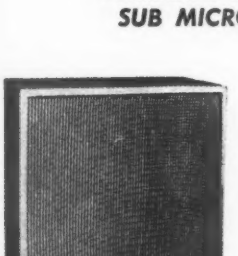


RUEMELIN MFG. CO.

3846 N. PALMER STREET MILWAUKEE 12, WIS., U. S. A.

MANUFACTURERS AND ENGINEERS — SAND BLAST AND DUST COLLECTING EQUIPMENT — WELDING FUME COLLECTORS

COMPLETE FILTRATION FOR SUB MICRON PARTICLES



Flanders **AIRPURE** Absolute Filters

Airpure absolute Filters combine the greatest dust holding capacity with the lowest resistance factor.

- 15% more dust holding capacity because of larger filter medium area.
- Filter medium has no binder to clog pores
- Filter medium has low initial P.D.

Rate it either way: 1000 CFM @ .75" W.G.
1300 CFM @ 1.00" W.G.

Many models available for a wide variety of applications.

Send for free illustrated Filtration Catalog.

FOREMOST PRODUCERS OF ABSOLUTE FILTERS FOR AEC INSTALLATIONS

AIRPURE Flanders Filters INC

BOX 718 RIVERHEAD L. I., N. Y.

FACTORY VENTILATION REPRINT NOW AVAILABLE

Reader response to our series of articles on Factory Ventilation has been so enthusiastic that Air Engineering has collected them in one convenient, 16-page, illustrated booklet. Entitled PRIMER ON FACTORY VENTILATION, the booklet gives useful data on:

- Make-up Air Problems & Solutions
- Heating System Controls
- Ventilation
- Cost Analysis
- Sizing Heating Equipment
- Safety Tips
- Air Distribution
- Employee Education

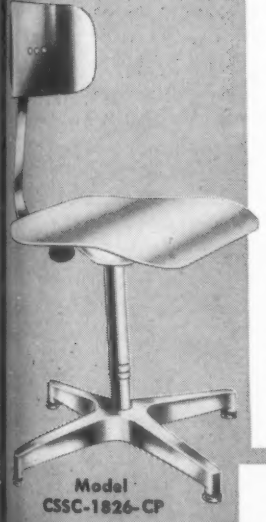
For your copy, write to:

Technical Literature Dept.
Air Engineering
450 W. Fort St.
Detroit 26, Michigan

or use convenient Communications Center card, page 57.

PRICE 75¢

SPECIAL CHAIRS FOR WHITE ROOMS AND DUST FREE AREAS



Model CSSC-1826-CP

- All Enclosed Mechanism
- No Oil or Grease
- All Chrome Plate Finish
- Easily Cleaned
- 12 Ga. All-Steel Seat; 14" x 15½"— Waterfall Form. Sand Blast Surface. Adjusts 18" to 26".
- 12 Ga. Steel Backrest; 6" x 13¾"—with tempered steel backrest support. 6 inch horizontal adjustment. Backrest folds down to make easy cleaning.
- Cast Iron Base; 20-inch spread. 1⅛" steel glides.

Other White Room chairs with lacquered plywood seat and backrest.

FREE TRIAL Use an AJUSTRITE chair for 30 days without obligation. Prove to yourself the many advantages AJUSTRITE offers in comfort, utility and economy. Write today—we'll do the rest.

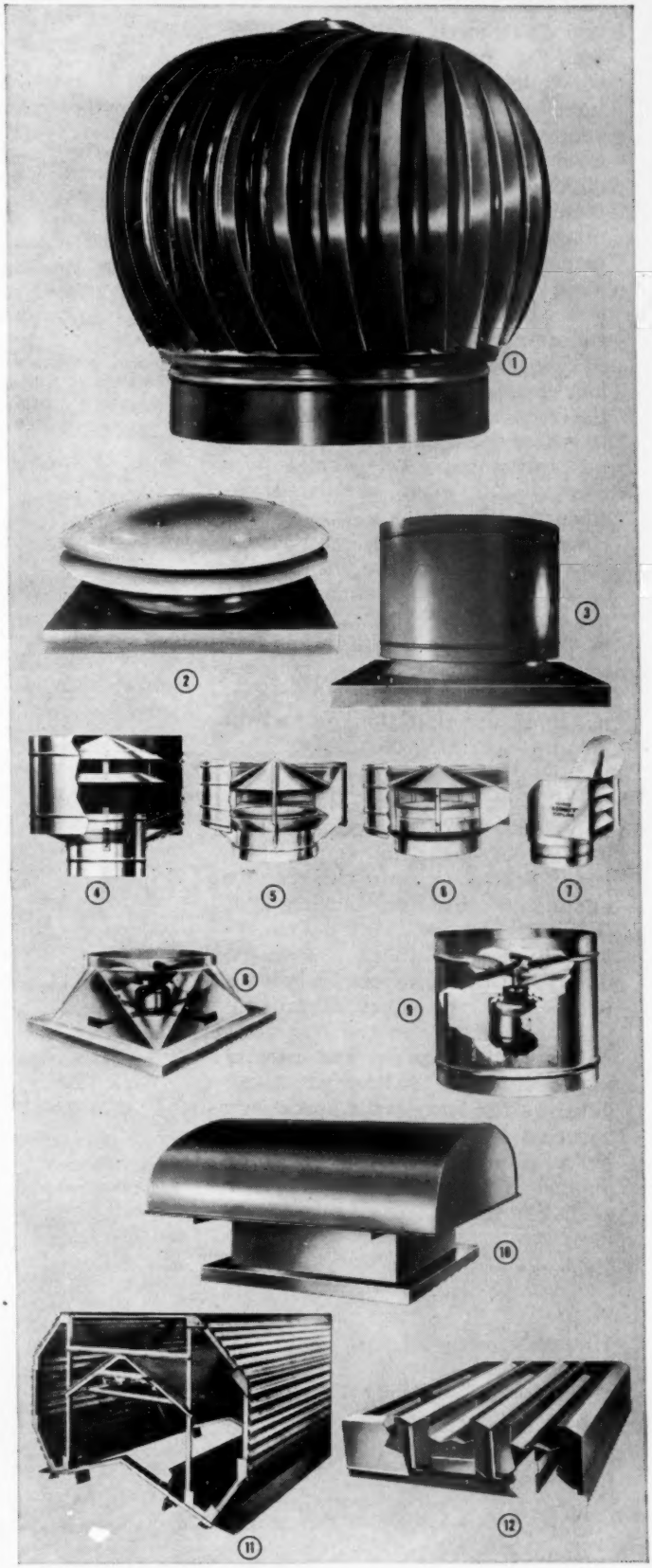
10 YEAR GUARANTEE

12 Models for Factories • Schools • Laboratories • Hospitals • Offices

AJUSTRITE CHAIRS AND STOOLS

AJUSTO EQUIPMENT CO.
Bowling Green, Ohio

No Need to Look Further...



Write today for nearest representative

WESTERN ENGINEERING AND MFG. CO.

P. O. Box 66455
Los Angeles 66, California

Complete Catalog in Sweets. Member Air Moving and Conditioning Assoc., Inc.

Beryllium Dust . . .

(Continued from page 62)

trol of airborne exposure to beryllium are: rigid selection of process components, local exhaust ventilation at all points, very careful operating procedures, unusually good housekeeping, and the introduction of suitable personal protection. In addition, frequent sampling of the atmosphere is also necessary to insure a continued high degree of control.

Because of the minute airborne concentrations which can be allowed, a general formula of operation has been conceived. This includes: the reduction of manual handling to an absolute minimum, keeping all process implements and equipment within their ventilated enclosures, elimination of any process step which appears to create excessive dustiness and the substitution of a less dusty step, elimination of all non-ventilated manual transfer of powdered materials, and an unusually close liaison between engineering and production personnel to assure that the control will suit the operating techniques.

Ten years of operation in a beryllium refinery and other plants has resulted in the development of a group of hoods and control procedures which have successfully eliminated any new incidence of beryllium disease. This article reviewed each of these operations, described the control procedures which have been effective and provided a summary of the results of air concentrations in and around all operations. Although these data are for large scale operations covering all types of processing, on a reduced scale they may be applied to very small operations of a similar nature. ▲▲

Table 7—*AUXILIARY OPERATIONS*

	Be concentrations, $\mu g/M^3$		
	Max.	Min.	Median
Housekeeping			
Wash floor (hose)	30	2.7	
Sweep floor			2.9
Vacuum floor			6.1
Laundry			
Load dry clothes			40
Remove wet clothes			1.1
General air	1.3	0.3	0.7
Lunch room	2.5	0.2	0.8
Locker room	3.9	0.2	0.8
Maintenance shop	0.7	0.2	0.5

Table 5

Miscellaneous Chemical Operations

		Be concentration, $\mu g/m^3$		
		Max	Min	Median
Filtration				
Clean large Sparkler	None	8.8	2.5	
Clean large Sparkler	None	21	0.3	2.3
Clean Hercules	Canopy hood	21	1.3	6.9
Clean basket centrifuge	Ring slot	6.7	3.9	5.3
Continuous centrifuge	Negative pressure on casing			
Change discharge drum		15	4.9	5.1
General air		0.9	0.2	0.6
Crushing				
Beryl jaw crusher	Ventilated enclosure			0.01
Beryl ball mill, charge	" "			0.02
Frit ball mill, general air	Unit under negative pressure	2.6	0.5	0.7
Ball mill, wet				
Charge	Booth	22	8.7	15
Dump	No ventilation, wet material	5.9	0.9	2.7
Electrolysis				
Sampling salt	Local exhaust			9.5
Hoe product				13.6
Dump product				10.4
General air				6.8

Table 6

Beryllium Production, Miscellaneous Furnace Operations

		Be concentration, $\mu g/m^3$		
		Max	Min	Median
BeF sublimation	Ventilated enclosure			
Charge retort				39
Insert liner				3.8
Remove liner	Ventilated buggy			1.0
Remove condenser	" "			2.8
General air				0.02
Sulfating furnace	Ventilated enclosure and local exhaust			
Ignite burner		15,000	3.8	22
Remove coverplate		85	2.1	4.0
Replace coverplate		13	0.8	5.0
General air		5.9	0.2	1.2
Beryl fusion	Ventilated, horizontal collar			
Pour	Canopy hood	15	1.3	7.4
General air		4.5	0.6	1.1
NH_4BeF_2 decomposition	Ventilated enclosure and local exhaust			
Change feed drum		19	1.9	3.5
Change discharge drum		24	2.2	7.6
General air		3.6	0.7	1.2
BeF reduction	Ventilated enclosure and local exhaust			
Charge		16	0.6	1.8
Pour		87	1.5	8.8
Change molds		56	2.7	14
General air		2.9	0.6	1.8
Beryl frit heat treatment	Rotary kiln, local exhaust at ends			
General air		2.6	0.4	1.4

? ? ? ? ? ? ? Questions & ANSWERS ? ? ? ? ? ? ?

Welding Shop Ventilation

Question:

We are working on a problem that involves ventilating, cooling and dehumidifying the air in a welding shop. The size of the shop is 50x100x15 ft. high, it has 27 ovens with the temperature in the ovens at 1400° F. Only half of the ovens work at any one time.

Temperature in the place reaches 120° in the summer time even with existing ventilating system that produces an air change every 3 minutes. Hoods over the ovens are not wanted.

Would you please let us know if you have published any articles on any similar job or if you have any suggestions or material that can help us.

ANSWER:

To determine cooling requirements of any work shop the following data is needed:

(a) Total Btu output of all hot processes. If quantity of moisture is large the latent as well as the sensible heat load should be determined.

(b) Dry bulb temperatures °F.

(c) Wet bulb temperatures °F.

(d) Globe thermometers (radiant heat) °F.

From (b) (c) and (d) the effective temperature should be computed. ET is an index of comfort, discomfort and physiological distress. ET less than 80 are desirable to present heat illness and distress; ET around 71 are desirable for comfort.*

Several methods are available for cooling work shops, they are:

(a) General ventilation

(b) Evaporative coolers

(c) Mechanical refrigeration

(d) Dehumidification with sorbent materials

(e) Shielding radiant surfaces.

The choice of the method or combination of methods depends on heat relief required and amount of money available for control.

If general ventilation is considered the total Btu output of all hot processes should be determined. This can sometimes be determined by gas consumption or fuel consumption readings. The average outdoor air temperature should be determined and the desired air temperature rise of the ventilating air. Usually from 5 to 10° rise is allowed. The cfm required is then computed from the equation

$$\text{cfm} = \frac{\text{Total Btu/hr. sensible heat}}{1.08 \times \text{temperature rise °F}}$$

Example: A process is giving off 2,000,000 Btu. The average summer outdoor temperature is 75°, a 10° rise is to be allowed. How many cfm is required to remove the heat?

$$\text{cfm} = \frac{\text{Total Btu/hr. sensible heat}}{1.08 \times \text{temperature rise}} =$$

$$\frac{2{,}000{,}000}{1.08 \times 10} = \text{cfm} — 185{,}000 \text{ cfm}$$

The cooler outdoor air should enter the shop where it comes in and cools the workers before passing hot processes. If some air velocity can be directed against the workers a lower ET will result. The air should discharge outdoors after passing the hot processes. The rates necessary are often much higher than an air change every three minutes, as large volumes of air are necessary.

Evaporative coolers on most summer days can give a lower ET temperature than outdoor air even in many localities in the middle west and east. Weather Bureau reports can be obtained. The degree of cooling by means of an evaporative cooler can be obtained from daily wet bulb, dry bulb temp. and a psychrometric chart. If a lower effective temperature will result; this air rather than outdoor air should be used.

Example: Outdoor air at 75°F D.B., 57°F W.B., 30% R.H. has an effective temp. of 68° at zero velocity. If this air is passed through an evaporative cooler with about 70% efficiency we will get discharge air at 63°F D.B., 57°F. W.B. with an effective temperature of 61° at zero velocity. The lower effective temperature index indicates a greater cooling capacity.

To estimate mechanical refrigeration required, the no. ton required

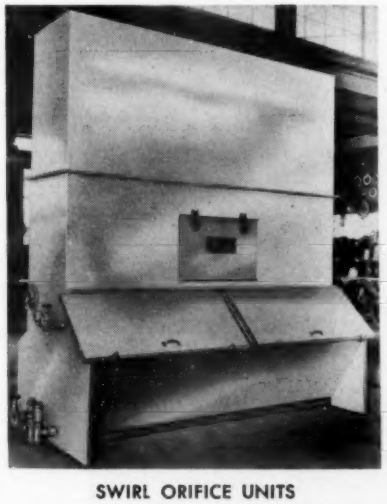
(Please turn to following page)

SCHMIEG INDUSTRIES, INC.

- Pioneers in the field of dust collection.
- Engineers and Manufacturers of wet type dust and fume collectors for over 25 years.
- *For information contact:*

Schmieg Industries, Inc.

Detroit 34, Michigan
Phone: JEfferson 9-1030



SWIRL ORIFICE UNITS
. . . for fumes and fine dust collection

VERTICAL ROTOR UNITS
. . . for buffing and foundry applications

(Continued from preceding page)

is computed from the equation.

$$Ht = \frac{\text{Btu per hour}}{12{,}000} = \text{Tons Refrigeration.}$$

If considerable latent heat or moisture is present, dehumidification can be achieved by sorbent materials. Activated aluminum oxide, silicon dioxide and lithium chloride are used for dehumidification.

Shielding of high temperature radiant surfaces can greatly improve heat exposures. Bright aluminum surface have a reflectance of about 95% and are used for shielding. Globe thermometer reading indicates the magnitude of the radiant heat exposure.

**Reference: Industrial Ventilation* 6th Edition, American Conference of Governmental Industrial Hygienists.

When To Change Filters

Question:

Please explain why it is suggested not to change all filters at one time, when all the filters *were,* at one time clean at the initial start of the system.

F.W.
Bristol, Conn.

ANSWER:

Air filters new and clean have a specified resistance to air flow for their rated volume flow (cfm). This resistance may range from about 0.1 in. of water for low and medium efficiency filters to as high as 1.0 in. and higher for high efficiency absolute type filters.

When the filters are in use dust, lint and particulate matter penetrate the filter, plugging the openings and increasing the resistance to air flow. A new filter having, say, an initial resistance of 0.1 in. water gauge may in use become dirty and plugged and have a final resistance of 0.5 in. of water or higher.

The relatively low pressure centrifugal fans used with these air filters are very sensitive to changes in resistance. The air flow (cfm) initially affected by the fan decreases with the increased resistance of the filter until adequate ventilation is no longer attained. The fan will therefore obviously produce a higher air flow initially when the filters are new and a lower air flow when the filters become plugged.

An ideal situation from the uniformity of air flow standpoint would be to maintain a filter of unvarying resistance, this could be achieved only by changing the filters at very frequent intervals. This is impractical from the operational standpoint and economically not feasible.

A simple approach to uniform air flow is to have at all times a bank of some filters partially plugged of higher resistance and some relatively clean of lower resistance; the overall resistance of the filter bank will be between the resistance of the filters of low resistance and the filters of high resistance. This gives a more uniform airflow and allows a larger use of the filters without having an inadequate low ventilation rate. This is the reason for not changing all the filters at one time. A good practice to assure changing the filters before the air flow becomes too low is to install a resistance gauge across the filter bank. This can be an inclined U-tube manometer or a filter gauge. ▲▲

OUR PRECISION WORK FOR THE AEC DEMANDS AN OUTSTANDING

AIR CONDITIONING ENGINEER

We have an unusual technical opening for an experienced Air Conditioning Engineer. Duties include formulation of advanced environmental projects and their presentation to management. Projects must be designed to cope with extremely critical environmental conditions for manufacturing, such as temperature control to 1/5 of a degree.

This is a high-level position for an engineer who is qualified to break new ground in the control of humidity, temperature and clean atmospheres. Salary level is designed to meet the requirements of the best men in the field.

You will be performing a key function with one of the nation's most vital industries. As an integral and extremely important part of the nuclear weapons program, we offer security, plus unusually generous company benefits, in a Midwestern community which is famous for its beauty and low cost of living.

Write to Box AE-10601, Air Engineering

PROFESSIONAL SERVICES

LAUREN B. HITCHCOCK ASSOCIATES
Chemical Engineers
Industrial Air Pollution Abatement
L. B. Hitchcock.....Edwin Cox
John H. Schaefer, Technical Advisor
60 East 42nd St., New York 17, N. Y.

CLASSIFIED ADVERTISING

POSITIONS WANTED

HAVE FILTER EXPERIENCE—WILL TRAVEL! More than twenty years' experience in every phase of the air filter industry. Design, production, research and development (eighteen patents), field application, test and service, distributor training and sales engineer. Available as direct factory representative in Southwestern or Southeastern states. Will accept research and development assignment on contract basis. BOX AE-10601, Air Engineering.

MISCELLANEOUS

TECHNIQUES OF DUCT WORK ESTIMATING — Learn how the pros figure the big jobs; by poundage — square footage — linear footage — fittings. This information is ordinarily very closely guarded and is invaluable to the progressive shop or individual. A limited volume of copies are being printed. Send check or money order for $3.50 payable to W. A. C. Co., Medway 4, Mass.

Use Communications Center, page 57, for requesting more information about articles, advertised products, literature, etc.